

DOCUMENTING SCIENTIFIC SESSIONS AT PICES XIII

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At PICES X (October 2001, Victoria, Canada), Science Board concluded that PICES had not well-documented the science contained in its Annual Meetings, with the exception of papers that were compiled later into PICES Scientific Reports or other publications. To enhance the documentation of PICES scientific sessions and workshops, Science Board recommended that convenors be asked to provide a summary of

their session/workshop, and these summaries be included in the PICES Annual Report.

The following are summaries of sessions and workshops convened at PICES XIII (October 2004, Honolulu, U.S.A.). In the "List of papers", talks are in the order of presentation and posters are sorted by the presenter's last name.

Science Board Symposium S1)

Beyond the continental slope - complexity and variability in the open North Pacific Ocean

Co-Convenors: R. Ian Perry (SB), Vladimir I. Radchenko (BIO), Yukimasa Ishida (FIS), John E. Stein (MEQ), Kuh Kim (POC), Igor I. Shevchenko (TCODE), Suam Kim and Harold P. Batchelder (CCCC)

Background

Most of the area of the North Pacific Ocean is in the pelagic realm, beyond the major currents and marginal seas that border the continents. This oceanic region has often been perceived as physically homogeneous and stable with low biological productivity. In reality, it is a spatially and temporally dynamic environment of high complexity. The diversity and structure of open ocean ecosystems are influenced by both the horizontal and vertical structures of the ocean's physical and biological properties and by their seasonal cycles. Sharp contrasts in oceanic bottom topography caused by seamounts and islands add additional structure and complexity. In spite of its relatively low primary productivity, the region supports complex ecosystems with high biodiversity, and is home to many endangered species. Marine resources are important to the peoples of the North Pacific and are fished by fleets from many Pacific Rim nations. This session sought to improve understanding of the physical, chemical and biological structure and dynamics of North Pacific oceanic waters far beyond the continental shelf, with particular emphasis on the subtropical gyre. The symposium considered how these complex subtropical oceanic ecosystems are structured and

maintained, in light of their generally low productivity. It provided opportunities to compare and contrast these areas with neighbouring regions of higher productivity, to investigate how important small and meso-scale features, such as fronts and eddies, are to the growth, survival and distribution of upper trophic level species, and how sub-tropical waters have been affected by recent global changes.

Summary of presentations

The session consisted of 13 oral presentations plus several posters. Papers dealt with causes and potential predictability of variations in the Pacific Decadal Oscillation, with large-scale environmental monitoring of physical conditions and circulation in the North Pacific, with regime-like changes in lower and upper trophic levels of the sub-tropical North Pacific, and with classification of marine pelagic environments in the open North Pacific Ocean. Variability, on both large and small temporal and spatial scales, was a dominant theme of these sub-tropical open ocean ecosystems, which is in marked contrast to the traditional view. Significant changes in physical conditions (warm and fresh to cold and salty) have been observed north of the Hawaiian Islands since 1996. These physical changes

have led to increases in phytoplankton and zooplankton, so that it is now clear that plankton biomass and biogeochemical fluxes in this region are not in steady-state, but have both high and low frequency variability. Different groups of organisms contribute to different frequencies of variability: for example, “daytime-resident” zooplankton (in contrast to night time vertical migrants) drive the decadal trend of increasing zooplankton biomass. The result is that the carrying capacity of these waters had increased from 1997 to 2002, due to increased entrainment of deep nutrients caused by deeper vertical mixing. Much of this increased productivity occurred in the very small size fractions of phytoplankton and zooplankton that have not

been sampled on traditional surveys. At larger spatial scales, the Kuroshio Extension region, and meso-scale eddies in general, are important locations for small pelagic fish recruitment processes, feeding of sea turtles, and sites of enhanced predator-prey interactions. However, these oceanic hotspots are highly dynamic, but the underlying processes that drive these events are poorly understood. It was also noted that mesopelagic micronekton, including fishes and invertebrates such as squids, are extremely important in open ocean environments of the North Pacific, which is in contrast to continental shelf ecosystems, but are also poorly understood.

List of papers

Oral presentations

Niklas Schneider (Invited)

The forcing of the Pacific Decadal Oscillation

Franklin B. Schwing, Roy Mendelssohn and Steven J. Bograd

When did the 1976 regime shift occur?

Howard J. Freeland

Argo as an aid to environmental monitoring and assessment - An example from the Gulf of Alaska

Jinping Zhao, Shujiang Li, Weizheng Qu and Jie Su

Long-term climate change in the Yellow Sea and East China Sea

Robert Bidigare, Y. Chao, R. Lukas, R.M. Letelier, S. Christensen and D.M. Karl

Temporal variations in phytoplankton community structure and physical forcing at Station ALOHA (22.75°N, 158°W)

Michael R. Landry and Cecelia C. Sheridan (Invited)

Zooplankton community complexity and temporal variability in the subtropical North Pacific

Michael P. Seki (Invited)

Processes and patterns at oceanic “hot spots” in the subtropical North Pacific

Akihiko Yatsu, Masatoshi Moku, Hiroshi Nishida, Kaori Takagi, Norio Yamashita and Hiroshi Itoh

Possible ecological interactions between small pelagic and mesopelagic fishes in the Kuroshio-Oyashio Transition Zone and Kuroshio Extension in spring

Denzo Inagake, Kazuyuki Uehara, Harumi Yamada, Koji Uosaki and Miki Ogura (Invited)

Relation between tuna resources and atmosphere-ocean variability in the North Pacific

Oleg N. Katugin and Gennadiy A. Shevtsov

Patterns of distribution and biology of the North Pacific oceanic squid *Beryteuthis anonychus* with implications for the species life cycle

Julie A. Hall

Links between biogeochemistry and ecosystems in marine environments

Edward J. Gregg, Karin M. Bodtker and Andrew W. Trites

Exploring the structure of the oceanic environment: A classification approach

Vadim F. Savinykh

Dynamics of plankton and nekton communities in the Western Subtropical Gyre

Posters

John R. Bower and Taro Ichii

The red flying squid (*Ommastrephes bartramii*): A review of recent research and the fishery in Japan

Alexander I. Glubokov and Serguei B. Popov

Results of Russian echointegration and trawl surveys in the Donut Hole during autumn 2003

Oleg N. Katugin and Evgenyi V. Slobodskoy

Population structure of the North Pacific oceanic squid *Ommastrephes bartramii* as inferred from variability in biological traits and genetic markers

Andrei V. Suntsov

Ichthyoplankton of the equatorial frontal zone east of Galapagos Islands

Andrei V. Suntsov

Species composition and abundance of mesopelagic fish assemblage on the periphery of the North Atlantic subtropical gyre

BIO Topic Session (S2)

Mechanisms that regulate North Pacific ecosystems: Bottom-up, top-down, or something else?

Co-Convenors: Douglas P. DeMaster (U.S.A.), George L. Hunt, Jr. (U.S.A.), Michio J. Kishi (Japan), Jeffrey M. Napp (U.S.A.) and Andrew Trites (Canada)

Background

Within the PICES region, dramatic changes have been observed in the past 50 years in the structure and function of marine ecosystems. In an effort to understand what caused these, often dramatic, changes, various hypotheses have been proposed as controlling mechanisms for entire ecosystems or for particular components of the ecosystems (*e.g.*, fish stocks and apex predators). Each of the hypotheses (*e.g.*, Trophic Cascade, Oscillating Control, Nutritional Stress and Regime Shift) has at its core a fundamental assumption that control is the result of bottom-up, top-down, or a wasp-waist trophic pyramid restriction. Is it really that simple? Are these hypotheses testable? Will they lead us to a predictive capability? The goal of this session was to review, based on observations and model results, the basic assumption (source of control), and to evaluate the strength and weaknesses of the individual hypotheses. The session examined these hypotheses, as applied to ecosystems and important marine populations from the western and eastern North Pacific Ocean, and explored how the different control mechanisms might affect the ability of managers to maintain sustainable fisheries in the region. The possibility of publishing the results in a special issue of a leading international journal will be explored

Summary of presentations

This session was extremely successful. The session had excellent attendance on both days, and there was only 1 cancelled talk (due to family illness). The session was conducted over 1½ days with 17 papers on the first day and 9 on the second day. The program included a good mix of overview/summary papers and specific examples of ecosystem control in the PICES region. A contribution from the U.S. National Marine Fisheries Service made it possible to increase the number of invited speakers from 2 to 5. In addition, one internationally renowned speaker who was in town for another meeting, was offered per diem support so that he could stay a few extra days and speak at the session. The invited speakers, many of whom have not traditionally attended PICES meetings, gave the symposium a very broad global ecosystem perspective.

A common theme in the session presentations was that it is rare to find systems that are regulated by only one mechanism. The term, “situational” control was presented by one speaker to refer to the potential for multiple modes of control. In addition, the general opinion of the presenters who addressed the subject was that prediction of the control and trajectory of ecosystems is very difficult and that we are a long way from predictive capability.

Several major conceptual ideas were presented during the session. Andrew Bakun presented new definitions for wasp-waist systems and the “predator pit” as a way to understand fluctuations of small pelagic fishes in upwelling systems. Philippe Cury urged investigators to regard both “pattern control” and “process control” in their investigations. Kenneth Drinkwater provided a well-documented example of a warming event in the 20th century and how it affected the cod-dominated ecosystem of the northern Atlantic Ocean. The “climate challenge” was presented by Kerim Aydin to demonstrate how auto-correlation can provide population fluctuations similar to those often attributed to climate and bottom-up forcing in marine ecosystems. At the end of the first day, Richard Beamish introduced a new term, “longevity overfishing”, to bring renewed attention to an old problem – lack of consideration of age structure in the fishing of long-lived species. A short, but lively discussion concluded the first day.

The second day began with a series of papers regarding fluctuations in populations of small pelagic fishes. Included in this was a presentation of the Cyclic Advantage Model by Hiroyuki Matsuda, which predicts the dominant fish species within the Kuroshio/Oyashio system. The session also examined control of other components of the marine ecosystem including squid, sea lions and seabirds. Yasunori Sakurai discussed control of squid populations, and showed a short film clip of the first squid egg mass photographed in the wild. The Ocean Climate Hypothesis was presented by Andrew Trites as a conceptual framework to explain both the decline and the potential stabilization of Steller Sea Lion populations. Evidence for physiological stress by breeding female Steller Sea Lions was presented by Alexander Kitaysky. The baleen whale – killer whale trophic cascade hypothesis was refuted by DeMaster *et al.*, and, to conclude the session, George Hunt discussed control mechanisms for seabirds and mammals, and how they might differ at scales from whole ocean basins to that of the foraging area of a single colony.

List of papers

Oral presentations

Mary E. Power (Invited)

Food webs, fluxes, and flow paths: A fluvial perspective

John C. Field, Robert C. Francis and Kerim Y. Aydin

Top-down modeling and bottom-up dynamics: Linking fisheries-based multispecies models with climate hypotheses in the Northern California Current

Jeffrey M. Napp, George L. Hunt Jr., Sue E. Moore and Christine T. Baier

Who is regulating zooplankton production (or How to resolve issues of control)?

Xuelei Zhang, R.X. Li, M.Y. Zhu, Z.L. Wang, L.H. Zhang, Y. Li and Y.J. Hao

Changes of net phytoplankton in Sanggou Bay, Northern China: Evidence for consumer regulation of primary producer

Philippe Cury (Invited)

Who is controlling whom in marine ecosystems: Observed changes, possible mechanisms and trends in top-down, bottom-up and wasp-waist controls

Andrew Bakun

Mechanisms of “wasp-waist” control in marine ecosystems

William Sydeman, John Calambokidis, Derek Lee, Steve Ralston, Dave Johnston, Chet Grosch and Francisco Chavez

Phase relationships and controls of the upwelling-dominated central California Current ecosystem

Vladlena V. Gertseva, Thomas C. Wainwright and Vladimir V. Gertsev

Juvenile salmon survival in coastal waters of the Northeast Pacific Ocean: Top-down or bottom-up control?

Jennifer L. Nielsen and Gregory T. Ruggerone

Top-down and bottom-up linkages among climate, growth, competition, and production of sockeye salmon populations in Bristol Bay, Alaska, 1955-2000

Bernard A. Megrey and Francisco E. Werner (Invited)

Evaluating the role of top-down versus bottom-up ecosystem regulation from a modeling perspective

Anne B. Hollowed and Vera N. Agostini

A review of the role of environmental disturbance and resource partitioning as a source of population regulation in marine ecosystems

Jie Zheng and Gordon H. Kruse

Recruitment variation of eastern Bering Sea crabs: Density-dependent, "climate-control", or "top-down" effects?

Kerim Y. Aydin, Sarah K. Gaichas and Patricia A. Livingston

Wasp-waist control and beer-belly oscillations: An evaluation of population hypotheses in the Bering Sea and Gulf of Alaska

Franz J. Mueter, Michael C. Palmer and Brenda L. Norcross

Bottom-up and top-down controls of walleye pollock on the Eastern Bering Sea shelf

Yongjun Tian, Hideaki Kidokoro and Tatsuro Watanabe

Long-term changes in fisheries production of the Japan Sea with emphasis on the impacts of fishing and climate regime shifts during the last three decades

Kenneth F. Drinkwater

Marine ecosystem responses to the warming of 1920s and 1930s in the northern North Atlantic

Richard J. Beamish and Gordon A. McFarlane

The natural regulation of long lived fishes and the impact of "longevity over fishing"

Hiroyuki Matsuda (Invited)

How to test, use and manage sardine-anchovy-chub mackerel cycles

Akinori Takasuka, Yoshioki Oozeki, Ichiro Aoki, Ryo Kimura, Hiroshi Kubota and Takashi Yamakawa

Differential optimal temperatures for growth of larval anchovy and sardine: A potential mechanism for regime shifts?

Rubén Rodríguez-Sánchez, Daniel Lluch-Belda and Sofía Ortega-García

Possible mechanisms underlying latitudinal abundance changes of Pacific sardine in the California Current system during the last warming regime (1980-1997)

Vera N. Agostini, Andrew Bakun and Robert C. Francis

Larval stage controls on sardine recruitment variability: Predation or food availability?

Yasunori Sakurai, Sachi Miyanaga and Jun Yamamoto (Invited)

Why do ommastrephid squids increase in abundance during warm regimes?

Andrew W. Trites, Arthur J. Miller and Herbert D. G. Maschner

Bottom-up forcing and the decline of Steller sea lions in Alaska: Assessing the ocean climate hypothesis

Alexander Kitaysky and Alan Springer

When, where and why Steller sea lions experience physiological stress - Evidence from stress hormones and diet quality

Douglas P. DeMaster, Paul Wade and Phillip Clapham

The cascading whale predation hypothesis: Testing with existing data

George L. Hunt Jr.

Are the control mechanisms of marine birds and mammals scale-dependent?

Posters

Igor V. Melnikov

Pelagic predatory fishes as consumers of Pacific salmon: Distribution in the Russian exclusive economic zone and adjacent waters, their abundance and some biological features

Hyunju Seo, Kibeik Seong, Suam Kim and Sukyung Kang

Interannual variability in chum salmon (*Oncorhynchus keta*) growth in relation to environmental change during the 1980s-1990s

BIO Topic Session (S3)

Role of gelatinous zooplankton in coastal and oceanic ecosystems

Co-Convenors: Richard D. Brodeur (U.S.A.) and Jun Nishikawa (Japan)

Background

Recent increases in gelatinous zooplankton in a number of ecosystems in the North Pacific and elsewhere have demonstrated the potential

importance of these organisms in energy transfer in coastal and oceanic environments. Gelatinous zooplankton exhibit rapid individual and population growth rates, and have been shown to be major consumers of phytoplankton,

zooplankton and early life stages of marine fishes, competitors with adult fishes, and conduits of energy transfer to the deep ocean. Despite their importance to the ecosystem, there are substantial gaps in our knowledge of the basic life history, ecology and environmental responses even for many of the dominant species. This session brought together information on diverse gelatinous taxa and examined their role in marine ecosystems and their responses to variable environmental conditions.

Summary of presentations

Nine oral presentations were made during this half-day session. The keynote talk by William Hamner provided an overview of the dominant strategies employed by marine organisms to avoid predation, and found many parallels with terrestrial biota. Adopting a cryptic lifestyle of gelatinous form is unique to the marine environment and has been adopted by numerous evolutionary diverse taxa, suggesting a strong selective pressure for this lifestyle. Our knowledge of gelatinous taxa has evolved in synchrony with advances sampling these fragile forms, particularly *in situ* observations. Jennifer Purcell summarized our current understanding of the effects of climate on jellyfish populations. She showed several long-term changes in gelatinous zooplankton that were related to environmental conditions, with temperature being most important, but anthropogenic effects also may be important in some situations. Mary Arai reviewed the dominant predators on jellyfish, and found that other jellyfish and fish were probably the most important predators.

List of papers

Oral presentations

William M. Hamner (Invited)

Gelatinous animals at sea: Convergent evolution and sampling problems

Jennifer E. Purcell

Climate effects on jellyfish populations: A review

Mary Needler Arai

Predation on pelagic coelenterates

Cynthia L. Suchman, Elizabeth Daly, Julie E. Keister, William T. Peterson and Richard D. Brodeur

Predation by the scyphomedusa *Chrysaora fuscescens* in the northern California

She provided evidence that jellyfish are likely underestimated in diets due to their rapid digestion times, but this may be ameliorated by consumption of vast quantities. An attempt to estimate the feeding impact of a dominant medusa in the California Current was made by Cynthia Suchman, based on medusa abundance, food habits, feeding rates, and prey standing stocks. She found substantial consumption of euphausiid eggs and less for copepods and other zooplankton prey. Evgeny Pakhomov pointed out the distribution of antarctic salp (*Salpa thompsoni*) may be shifting southward over the past half a century with some evidences of damaged populations in the high latitudes, and these shift may indicate a large-scale environmental shift in Antarctic ecosystems. Russell Hopcroft studied egg production rates, growth, and production of larvacean community in the Northern Bering Sea, and suggested their ability to both outgrow and out-reproduce copepod populations. Kiyotaka Hidaka investigated biomass and distribution of larvacean communities around the Kuroshio waters in winter-spring, and suggested their importance in terms of production in that area. Michael Dagg presented research on larvacean production and stomach contents of juvenile salmon in the coastal regions of the Gulf of Alaska, and found that larvaceans play an important trophic role to link between small phytoplankton and juvenile pink salmon. Marsh Youngbluth gave a presentation on his research on predatory habits of the siphonophore (*Nanomia cara*) in the Gulf of Maine, and suggested the difference on vertical distributions and food habits between the coastal and deep ocean.

Evgeny A. Pakhomov

Long-term changes in salp distribution in a polar ecosystem: Some like it hot

Russell R. Hopcroft and Cheryl Clarke

Community composition and production of larvaceans in the Northern Bering Sea

Kiyotaka Hidaka and Kaoru Nakata

Appendicularians around Kuroshio in winter-spring

Michael Dagg, H. Liu, R. Sato, J. Armstrong and L. Haldorson

Trophic roles of larvaceans in the coastal regions of the Gulf of Alaska

Marsh Youngbluth, Charles Jacoby, Francesc Pages, Franz Uiblein and Per Flood

A comparison of predatory habits of the physonect siphonophore *Nanomia cara* in coastal basins (Wilkinson and Georges, Gulf of Maine) and deep-water canyons (Oceanographer and Hydrographer)

Posters

Pei-Kai Hsu, Wen-Tseng Lo and Ming-An Lee

Seasonal distribution of siphonophores in relation to the water masses in the East China Sea, north of Taiwan

Atsushi Kaneda and Hidetaka Takeoka

Relationship between short-term increases of gelatinous zooplankton and physical environments in the near shore area of Iyo-Nada,

Young-Shil Kang, Hye-Eun Lee, Soo-Jung Chang and Min-Ho Son

Predation pressure of some fishes on *Aurelia aurita* (Scyphozoa: Semaestomeae)

Young-Shil Kang, Min-Ho Son, Soo-Jung Chang and Hye-Eun Lee

New finding on young *Nemopilema nomurai* (Scyphozoa: Rhizostomeae) in the western coastal area of Korea

Takeshi Kohama, Shinya Nagano, Noboru Okuda, Hitoshi Miyasaka and Hidetaka Takeoka

Estimation of ecological role and trophic level of jellyfish *Aurelia aurita* using stable isotope ratios in the Uwa Sea, Japan

Shinya Magome, Tomohiro Yamashita, Takeshi Kohama and Hidetaka Takeoka

A study on jellyfish patch formation using aerial photography

Shwu-Feng Yu, Wen-Tseng Lo, Wei-Cheng Su and Don-Chung Liu

Winter distribution of siphonophores (Cnidaria) in the waters surrounding Taiwan

Evgeniy N. Ilynskiy and Alexander V. Zavolokin

Abundance and distribution of jellyfishes in epipelagical of the Okhotsk Sea

FIS/BIO Topic Session (S4)

Hot spots and their use by migratory species and top predators in the North Pacific

Co-Convenors: Churchill B. Grimes (U.S.A.), Yukimasa Ishida (Japan), Hidehiro Kato (Japan) and William J. Sydeman (U.S.A.)

Background

This symposium sought to examine and explain patterns of physical and biological spatial variation in open ocean habitats in the PICES region. The topic session was designed to be multi-disciplinary, with presentations ranging from physical oceanography to marine mammals. Specifically, we investigated the hypothesis that “hot spots” of biological activity, can be found in the North Pacific and that top predators aggregated at these specific sites for feeding, migration and reproduction. Furthermore, we hypothesized that tight physical-biological coupling contributes to the

formation of hotspots, and as such, many hotspots like currents, fronts and eddies are dynamic in space and time. Therefore, the spatio-temporal persistence of hotspots, and the oceanographic mechanisms supporting high levels of biological activity, was a pervasive question addressed at the topic session.

Summary of presentations

A total of 21 oral and 5 poster presentations were made. Six presentations were focused on physical oceanography and lower or mid trophic level organisms, with the remainder on upper trophic level organisms. Methods ranged from

shipboard surveys to satellite telemetry and trace element otolith analysis. Most presentations made use of remote sensing to characterize large-scale physical and biological hotspots. There were also at least 3 other presentations made in other topic sessions that specifically addressed hot spots in the marine environment. We found that many hotspots were persistent in time and space, but the mechanisms supporting their formation and persistence were not well understood. Moreover, while many top predators appeared to be found in regions of elevated chlorophyll *a* (as indexed by SeaWiFS or MODIS), the prey fields supporting predator aggregations were generally unknown. Finally, the significance of hot spots to growth and

reproduction and the population dynamics of marine species are not well understood. Therefore, our discussion focused on how to obtain the information needed to complete the picture of hot spot ocean habitat – predator coupling. The discussion of the implications of hotspot identification focused on the analyses of optimal foraging theory, fisheries management and the design of marine protected areas. In summary: the topic session was successful, with many high quality presentations. Nonetheless, many questions concerning the functional significance of open ocean habitat hotspots and the application of this information to fisheries and ocean management remain to be answered.

List of papers

Oral presentations

Franklin B. Schwing, Steven J. Bograd, Cara Wilson, Petra M. Stegmann, Barbara Block and Daniel Costa (Invited)

An oceanographic basis for identifying biological hot spots

Cara Wilson

Chlorophyll hot spots in the oligotrophic North Pacific Subtropical Gyre

Sukyung Kang, Suam Kim, Kevin Telmer, David Welch and Youn-Ho Lee (Invited)

Configuration of migratory history based on analyses of stable isotopes and trace elements in otolith of the North Pacific chum salmon

Robert Suryan, David Hyrenbach, Fumio Sato, Kiyooki Ozaki, Gregory Balogh, Paul Sievert, Daniel Roby and David Anderson

Foraging destinations of short-tailed albatrosses (*Phoebastria albatrus*) in the Northwest Pacific Ocean, Gulf of Alaska, and Bering Sea

Peter Etnoyer, D. Canny, B. Mate and L. Morgan (Invited)

Persistent pelagic habitat in the Northeast Pacific

Daniel Costa, Barbara Block, Steven J. Bograd, Randy Kochevar and TOPP Science Team (Invited)

Tagging of Pacific Pelagics (TOPP): Using electronic tags to discover hot spots in the pelagic realm

Rogelio Gonzalez-Armas, A. Muhlia-Melo, A. Trasiña-Castro, G. Gutierrez De Velasco, A. Valle-Levinson and R. Funes-Rodriguez

Differences in large pelagic fish larvae and zooplankton volumes over and around a seamount in the Gulf of California

Anatoliy Ya. Velikanov

Seasonal frequency of pelagic fish species in some micro-regions of the southwestern Okhotsk Sea

Shingo Kimura and Katsumi Tsukamoto

Landmark for the spawning of Japanese eel

Youn-Ho Lee, Geoyoung Kang, Woongsic Jung, Ki-Baek Seong, Suam Kim and Gisic Min (Invited)

How to discriminate the aggregated stocks of migratory species according to their origins: A simple and quick PCR method utilizing stock-specific single nucleotide polymorphisms

Brian K. Wells, Churchill B. Grimes and Jim Waldvogel

The effects of ENSO events on California chinook salmon (*Oncorhynchus tshawytscha*) as revealed by scale increment analysis

Hiroshi Ohizumi and Hikaru Watanabe (Invited)

Stomach contents of toothed whales in relation to prey distribution in the North Pacific

Scott M. Gende and Mike Sigler

Persistence of prey “hot spots” in southeast Alaska

Ivonne Ortiz and Kerim Y. Aydin

Hot spots for dining - A groundfish’s view

K. David Hyrenbach, William J. Sydeman, Ken H. Morgan and Peggy P.W. Yen

Upper-trophic predator hot spots in the California Current system: A retrospective analysis of marine bird and mammal communities

Robert S. Schick and Molly Lutcavage

Using GIS to locate pelagic hot spots for bluefin tuna

Takashi Kitagawa, Andre Boustany, Chris Perle, Charles Farwell, Tom Williams, Heidi Dewar and Barbara Block

Horizontal and vertical movements of juvenile bluefin tuna (*Thunnus orientalis*) in relation to seasons and oceanography in the eastern Pacific

Douglas C. Reese and Richard D. Brodeur

Identifying biological hot spots within the northern California Current

Mukti Zainuddin, Katsuya Saitoh and Sei-ichi Saitoh

Detection of high productive area of albacore fishing ground and migration route using multi-sensor satellite remote sensing

Yoshihiro Fujise, Koji Matsuoka, Hiroto Murase, Shigetoshi Nishiwaki and Hidehiro Kato

Existence of hot spots of large sized baleen whale concentration in pelagic zone of the western North Pacific; its biological and oceanographical features

Vincent F. Gallucci and Gordon H. Kruse (Invited)

Recent advances in knowledge of cold water sharks in the North Pacific Ocean

Posters

Sachihiko K. Itoh and Shingo Kimura

Transport and migration of larval and juvenile fishes through oceanic fronts

Patrick D. O'Hara, Peggy P. Yen, Chris Rintoul, Ken H. Morgan, K. David Hyrenbach and William J. Sydeman

Pelagic habitat hot spots as revealed by replicate seabird surveys in the NE Pacific

John E. Richert, Salvador J. Jorgensen, Arturo Muhlia Melo and A. Peter Klimley

Seamounts as hot spots of pelagic fish diversity in the Eastern Pacific Ocean

Victor R. Foux and Eugene V. Samko

Transport of fodder plankton in low-frequency waves and eddies: Favorable conditions for fishing grounds formation

Robert Suryan, David Anderson, Daniel Roby, David Hyrenbach, Scott Shaffer, Yann Tremblay, Jill Awkerman, Mark Westbrock, Karen Fischer, Fumio Sato and Kiyooki Ozaki

Wing loading and prevailing winds: Their relative importance to the at-sea distribution of four species of Pacific albatrosses

Galina A. Vlasova

Zone of "hot spots" of the surface temperature for the NW Pacific

Douglas Yelland

Backscatter variability within a Haida Eddy

MEQ Topic Session (S5)

Natural and anthropogenic introductions of marine species

Co-sponsored by the International Council for the Exploration of the Sea (ICES)

Co-Convenors: William P. Cochlan (U.S.A./PICES), Yasuwo Fukuyo (Japan/PICES) and Stephan Gollasch (Germany/ICES)

Background

Species introductions are among the most prevalent of human activities affecting natural ecosystems. In the marine environment, introductions, including most aquaculture initiatives, have resulted in both positive and negative effects. The transport of invasive species, such as phytoplankton, is thought to

stem from range extensions associated with fluctuating oceanographic conditions (*e.g.*, El Niño), severe storm events (*e.g.*, typhoons), and human activities (*e.g.*, ballast water). The impact of transport processes on species distributional changes in North Pacific waters is not fully understood. Relative to the terrestrial environment, the study of introductions, and the potential for new species to become invasive, is

in its infancy in marine systems. Emerging work includes introduction vectors, life history characteristics of invasive species, ocean conditions responsible for invasions, ecosystem resistance to invasion, and potential for eradication or mitigation of introductions once established. This session sought to answer three fundamental questions: 1) What is known about different transport mechanisms? 2) What is the magnitude of ecological and economic effects arising from the transport of species? and 3) What steps can be taken to minimize real or potential effects of existent and future invasive species? The current session is particularly timely given that the IMO Ballast Water Management Convention was signed in February 2004, and is now awaiting ratification.

Summary of presentations

The session consisted of 11 oral presentations and 1 poster, representing authorship from five PICES nations: Canada, Japan, Korea, Russia and the United States, and six non-PICES nations: Australia, Germany, Ireland, Italy, Mexico and New Zealand, as well as ICES. Despite the broad range of invasive topics selected for this session, the attendance was modest. The late cancellation of one oral presentation permitted careful discussion and additional questions for each of the talks: an opportunity well received by those in attendance. The session's presentations were organized around 1) the case histories of invasives, including both pelagic and benthic organisms, 2) descriptive and mathematical analyses of invasive vectors and their relative importance in various marine systems, and 3) management of invasion vectors, followed by discussion of any aspect of the session and consideration of future workshop ideas.

After brief introductory remarks by one of the co-convenors (S. Gollasch), the first invited speaker (Gustaaf Hallegraeff) discussed the role of ship's ballast water in spreading harmful algal bloom (HAB) species in Australian coastal waters, including the presence of culturable *Pseudo-nitzschia* diatoms and *Pfiesteria piscisida* dinoflagellates in ballast waters. His presentation also discussed the special problem

of invasive cysts, methods to determine if these invasive cysts have firmly established themselves in new environments, and the treatments to remove invasive species in ballast waters or destroy their viability. The next two speakers continued with case histories of invasive species, including the seaweed *Undaria pinnatifida* and their molecular identification (Shinya Uwai), and a Russian study of the invasive success of benthic species (polychaetes and phoronids) in the more ecologically stressed and contaminated regions of the Peter the Great Bay (Tatiana Belan).

Majorie Wonham, our next invited speaker, discussed the various hypothesis used to describe the apparent increase in marine biological invasions. Using existent data sets (from six independent marine systems), she demonstrated that often more than one model (linear, exponential and exponential) can describe temporal invasion trends, and outlined the difficulty of interpreting species invasions without consideration of both introduction rates and survival probabilities. Stephan Gollasch (invited ICES speaker) posed the question of whether ballast water was the key vector for aquatic species invasions. His presentation reviewed the relative importance of the various vectors for species introductions in twelve marine regions around the world, and demonstrated that hull fouling, ballast water and aquaculture were the most important vectors in all regions considered. However, his analysis also showed that the relative importance of these vector is regionally specific, and that hull fouling, not ballast waters, was the dominant vector in 60% of the regions considered; a conclusion which suggests that increased international regulation of ballast water introductions will not necessarily eliminate or decrease species invasions in all regions. Dan Minchin continued with the theme of vectors, and showed the importance of small craft, (open boats, yachts and cruisers) in transporting invasive species, and how their relative importance has appeared to increase with the growing number of citizens capable of owning and operating such craft. His analysis also demonstrated the importance of marinas as exchange points for invasives from the primary

vector of shipping to the secondary vector of small craft which further increase their range extension to areas inaccessible by shipping alone.

Yasuwo Fukuyo, in a series of back-to-back presentations, outlined the IMO Ballast Water Management Convention, its history and articles, and most importantly the challenges present in obscure wording (*e.g.*, viability) and the availability of reliable scientific methods to support the performance standards outlined in the convention. A very promising technique (Special Pipe) designed in Japan to terminate ballast water organisms using shear stress and cavitation was described, and its tests of efficacy presented. Jennifer Boehme outlined a verification system to ensure that mid-ocean ballast water exchange procedures are actually conducted based on the optical characteristics of chromophoric dissolved organic matter (CDOM) present in the original ballast water. She showed that statistics could be effectively used to discriminate the variability of CDOM fluorescence in various oceanic and coastal regions, and that such an analysis could offer a verification system independent of port salinity. Scott Godwin described recent efforts to identify and control species introductions associated with hull-fouling - the principle invasive vector in Hawaiian waters, using a risk-management approach based on a relative fouling risk associated with various vessels and the dynamics of their arrival in Hawaiian ports. The

final oral presentation by Stephan Gollasch was an introduction to the history, practices and work products resulting from the ICES efforts on the introductions of marine organisms. He concluded with a number of suggestions including the establishment of a PICES Working Group on *Species invasions* (not limited to HABs), and the reciprocal attendance of PICES and ICES members at their annual meetings and working sessions. He urged PICES member countries to follow the "ICES Code of Practice for the Introduction and Transfer of Organisms" when planning species introductions, and emphasized the need for both regional and global networks to most efficiently deal with biological invasions, given that an invasive species could originate from a non-PICES nation.

The session was concluded by a lively discussion led by Dr. Fukuyo where representatives of all PICES member countries in attendance agreed upon the establishment of a Working Group on *Marine invasive species*. Such a working group will serve as a means to create awareness of the species invasion problem, encourage additional scientific research on the issue, and enhance funding opportunities dealing with marine invasive initiatives in PICES member countries, and eventually may support the timely ratification and implementation of the IMO Ballast Water Management Convention.

List of papers

Oral presentations

Gustaaf M. Hallegraef (Invited)

Range extensions and ship ballast water transport of harmful algal bloom species in the Australian region

Shinya Uwai, Wendy Nelson, Luis E. Aguilar-Rosas, Sung Min Boo and Hiroshi Kawai

Introduced seaweeds - Genetic diversity of introduced and native *Undaria pinnatifida*

Tatyana A. Belan

Anthropogenic invasion of some benthic species in the coastal areas

Marjorie J. Wonham and Elizaveta Pachepsky (Invited)

What do temporal trends in invasion records really mean?

Stephan Gollasch (Invited)

Ballast water - The key vector for aquatic species invasions?

Dan Minchin, Anna Occhipinti, Oliver Floerl and Dario Savini

Small craft as a vector of exotic species

Yasuwo Fukuyo

The Ballast Water Convention and its inherent, but inevitable incompleteness for the prevention of biological invasion

Jennifer Boehme and Mark Wells

Ballast water exchange verification using the optical characteristics of dissolved organic matter

Yasuwo Fukuyo, Takeaki Kikuchi, Katsumi Yoshida and Seiji Kino

Onboard ballast water treatment using the special pipe to terminate aquatic organisms

L. Scott Godwin

Marine invasive species transported by vessel hull fouling: Potential management approaches

Stephan Gollasch

ICES and biological invasions - introduction to the work of ICES Working Group on Introductions and Transfers of Marine Organisms and ICES/IOC/IMO Working Group on Ballast and Other Ship Vectors

Poster

Alexei M. Orlov

Ichthyofaunal exchange between northwestern and northeastern Pacific: Possible directions and mechanisms

MEQ Topic Session (S6)

Marine Protected Areas

Co-Convenors: Glen Jamieson (Canada) and Qui-Lin Zhou (People's Republic of China)

Background

Marine protected areas (MPAs) are increasingly being recognized as both a fishery management tool and means to re-establish reference areas of relatively undisturbed biodiversity and productivity. There are proposals to declare substantial (20-30%) portions of all habitats as fully protected as is possible, and some studies suggest that this action may enhance local fisheries. The goals of this session were: (i) to review the nature and characteristics of existing and proposed MPAs in PICES countries; (ii) to review scientific data as to the utility of MPAs in improving our understanding of marine ecosystems and in fishery enhancement; and (iii) to compare experiences with MPAs in both tropical and temperate waters.

Summary of presentations

The session consisted of 6 oral presentations plus 1 poster. The invited paper dealt with the Australian experience in the development of its MPA network in federal, offshore (>3 nautical miles (about 5 km) waters, based on a marine bioregionalisation (ecoregion) program. Geomorphic and bathymetric mapping were the most useful tools for MPA development, as good biological and oceanographic data are limited. Two papers focused on methods and processes related to the identification of priority

conservation areas, one in the entire Northeast Pacific (from Baja California to the Bering Sea) and the other in northern British Columbia. Priority determination in the former paper reflected both conservation and the threats and opportunities to protecting sites, while the latter considered a complex of conservation objectives (representative, rare and distinctive features) in an analysis that evaluated how best to minimize the total areas suggested for protection to achieve desired objectives. Specific high "conservation utility" areas were consistently identified. Another paper looked at the effectiveness of a specific gear restriction (trawl exclusion zones) as a means of mitigating competition for a pelagic fish (Atka mackerel) between fishers and an endangered mackerel predator (Stellar sea lions). Because of the mobility of both prey and predator, exclusion zone size was found to be very important, arguing that MPA boundary design needs to consider habitat requirements, local abundance and movements of the species involved. This view was supported by a more theoretical study that considered a spatial model that allowed for fish movement due to processes of diffusion, directed movement and density dependent habitat selection. The goal of this latter study was to develop predictive approaches to help allow stakeholders to evaluate costs and benefits of establishing MPAs on fisheries for representative groundfish species. Finally, a

paper summarized the types of MPAs established in Korea, pointing out the challenges involved in protecting areas where human environmental impacts are extensive and have occurred for relatively long time periods. Goals here tended to be on population restoration and conservation of species' reproduction areas, rather than the conservation of relatively pristine areas. Collectively, the papers provided very

interesting insights into the challenges of establishing effective conservation areas and reducing human impacts on marine ecosystems. Presentations showed variable approaches, and showed that consideration of socioeconomic factors is as important as consideration of biological ones in the development of an effective regional MPA network.

List of papers

Oral presentations

Peter Taylor (Invited)

Offshore MPAs: The opportunities and the challenges

Lance E. Morgan, Sara Maxwell, Fan Tsao, Tara Wilkinson and Peter Etnoyer

Identifying priority conservation areas for the Baja California to Bering Sea region

Inja Yeon

Korean Marine Protected Areas

Elizabeth A. Logerwell and Susanne F. McDermott

The utility of trawl exclusion zones for protecting local aggregations of Atka mackerel in the Aleutian Islands, Alaska

Glen S. Jamieson and Jeff Ardron

Marine protected areas in Pacific Canada: an approach for network design

William de la Mare

Methods for evaluating the potential effects of MPAs on adjacent fisheries

Poster

Galina V. Moyseychenko and G.S. Borisenko

Ecologic and fishery studies in marine protected areas

POC/MONITOR Topic Session (S7)

Application of Global Observing Systems to physics, fisheries, and ecosystems

Co-sponsored by Argo

Co-Convenors: Michael G. Foreman (Canada), Vyacheslav B. Lobanov (Russia), Phillip R. Mundy (U.S.A.) and Sei-Ichi Saitoh (Japan)

Background

Problems such as global climate change, carbon cycling, ocean circulation forecasting, and variability in biomass and fish abundance have necessitated a great increase in the variety and quantity of ocean measurements. In response to these growing demands, the last two decades have seen a proliferation of new technologies for remotely sensing the physical and chemical properties of oceans and the biological characteristics of organisms living in them.

Noteworthy examples include the TOPEX/Poseidon/Jason and ERS/Envisat satellites for sea surface heights, SeaWiFS and MODIS for ocean colour, and Argo profiling floats for deep ocean velocities, temperatures and salinities. Technologies such as these have allowed interdisciplinary, near-realtime sampling of the global ocean with unprecedented resolution in time and space. This session highlighted the application of these new technology observing systems to the description and better understanding of

important physical, fishery and ecosystem processes in both the global, and more specifically, the North Pacific Ocean.

Summary of presentations

The session consisted of 19 oral presentations and 9 posters covering a wide range of observing systems and applications. The relatively recent availability of Argo float data was described and sample applications were illustrated in one invited presentation, while two other presentations used these data to track anomalous water features in the Gulf of Alaska. The underlying message was that as more floats are deployed and the oceanographic community becomes more familiar with its uses, Argo data can be expected to become a standard tool, much like the complementary information provided by satellite altimetry, for monitoring and analysing ocean conditions. In a similar vein, three papers focused solely on the application of satellite altimeter data: one to determining seasonal current patterns, a second to improving the accuracy of a regional tidal model, and a third to computing geostrophic currents for larval transport studies. The most frequently described data were sea surface temperatures (SSTs), customarily obtained via AVHRR, and ocean

colour obtained through a variety of sensors such as SeaWiFS, MODIS and GLI. One paper described the validation of algorithms for interpreting these ocean colour measurements while two others applied colour observations to describe phytoplankton distributions and variability in specific regions. In yet another paper, both data types were used to devise an anchovy availability index for the waters off northern Chile. Several numerical models using a variety of techniques to assimilate various types of data (including most of those referred to above) were also described. Two presentations were unique in the observing systems they described. The first summarized the development of, and initial results from, an acoustic tracking array along the North American shelf, while the second used the results from a continuous plankton recorder, in conjunction with sea bird measurements, to characterize meso-marine ecosystems in the North Pacific. Overall, the session was a success. All participants came away with the lasting impression that the development of remote observing systems within the last two decades has greatly facilitated ocean monitoring and greatly enhanced our ability to describe, understand, and forecast numerous physical, fishery, and ecosystem processes.

List of papers

Oral presentations

W. John Gould and Dean Roemmich (Invited)

The Argo Project: New observations of the physical state of the ocean and their potential application to climate, including fisheries and ecosystems impacts

William Crawford, Peter Sutherland and Peter van Hardenberg

Origin and persistence of anomalously cold water in the halocline of the Eastern Gulf of Alaska, 2002 to 2004

Toshiyuki Sakurai, Yukio Kurihara and Tsurane Kuragano

A new daily SST product of JMA (merged satellite and *in-situ* data Global Daily SST)

Dmitry D. Kaplunenko, Vladimir I. Ponomarev, Young J. Ro, Olga O. Trusenkov and Serge T. Trusenkov

Climate variations during the 20th century in the Northwest Pacific region

Masafumi Kamachi, Shiro Ishizaki, Norihisa Usui, Yosuke Fujii and Toshiya Nakano (Invited)

Data assimilation in the Pacific Ocean as an application of an observing system to physical oceanography and climate research

George Shevchenko and Alexander Romanov

Seasonal variations of Okhotsk Sea circulation from Topex/Poseidon satellite altimetry data

Michael Foreman, Josef Cherniawsky and Patrick Cummins

A high-resolution assimilating tidal model for the Bering Sea

Gennady A. Platov and Elena N. Golubeva

Seasonal variation of the salinity belt structure off the Primorie coast: A numerical study

Donald R. Kobayashi (Invited)

Application of satellite remotely sensed environmental data to pelagic larval transport, growth, and survival

P. Ted Strub, Corinne James and Andrew C. Thomas

Comparison of climatic signals (winds, satellite SSH, SST and surface chlorophyll-a pigment concentrations) in the NE and SE Pacific: 1993-2004

Kosei Sasaoka, Sei-ichi Saitoh, Hiroaki Sasaki, Tsuyoshi Miyamura and Tsutomu Yoshida

Bio-optical properties and in-water algorithm validation for ocean color remote sensing in the sub-arctic North Pacific

Hiroki Takemura and Sei-ichi Saitoh

Temporal and spatial variability of phytoplankton biomass and productivity in the Eastern Kamchatka Current region and along the Kuril Islands

Angelica Peña and William Crawford

Phytoplankton distribution in the Queen Charlotte Basin: Regions of high productivity

David Welch

POST: The development of a permanent continental-scale acoustic tracking array for west coast fisheries research

Claudio Silva, Eleuterio Yáñez, Karen Nieto, María Angela Barbieri and Guillermo Martínez

Spatial anchovy availability index for northern Chile

Sonia Batten, David Hyrenbach, William Sydeman, Ken Morgan, Mike Henry, Peggy Yen and David Welch

Characterising meso-marine ecosystems of the North Pacific

Michelle Li and Paul Myers

Mixed layer depth variability in the Gulf of Alaska from Argo and from ship-based observations

Gleb Panteleev, Dmitri Nechaev and Motoushi Ikeda

Summer circulation in the Bering Sea derived as a variational inverse of climatological data

Mao-Chang Cui and Mo Jun

El Niño Phenomenon in SODA data

Posters

Yury N. Volkov, Igor E. Kochergin, Alexey F. Scherbinin, Pavel A. Fayman, Sergey I. Rybalko and Mikhail V. Mishchenko

Diagnostic simulation of Peter the Great Bay (Japan Sea) currents

Pavel A. Fayman

Diagnostic simulation of the Japan Sea currents

Pavel A. Fayman

Diagnostic simulation of the Okhotsk Sea currents

E. Godínez-Domínguez, C. Franco-Gordo, G. Lucano-Ramírez, S. Ruíz-Ramírez, J. Rojo-Vázquez and J. Freire

Main effects of the 1997-1998 ENSO event in the tropical coastal ecosystem in the Mexican Central Pacific

Nikolai A. Maximenko and Pearn P. Niiler

Improved decade-mean sea level of the North Pacific with mesoscale resolution

Sung-Hyun Nam, Jong-Jin Park, Yun-Bae Kim, Young-Ho Kim, Duk-Jin Kim, Kyung-Ae Park, Jae-Yul Yun, Woo-il M. Moon and Kuh Kim

Observing systems in the East (Japan) Sea: A monitoring buoy with moored instruments, surface and subsurface drifting floats, and satellite measurements

George Novinenko and George Shevchenko

Satellite data based determination of SST spatial structure and the forecast of seasonal changes in the Okhotsk Sea

Jong-Jin Park, Kyung-Ae Park, Kuh Kim and Yong-Hoon Youn

Upper ocean response to typhoons and tropical storms

Roberto M. Venegas, P. Ted Strub, Emilio Beier, Ricardo Letelier and Andrew Thomas

Interannual and seasonal variability of satellite-derived chlorophyll pigment, sea surface height, temperature and wind stress in the northern California Current system

POC Topic Session (S8)

The impacts of climate change on the carbon cycle in the North Pacific

Co-sponsored by the International Ocean Carbon Coordination Project (IOCCP)

Co-Convenors: Kitack Lee (Korea) and Christopher L. Sabine (U.S.A.)

Background

Many recent studies have investigated carbon cycle variability in the central and North Pacific. A significant number of these studies have been related to the effects of El Niño-Southern Oscillation (ENSO) on the upwelling regions of the Equatorial Pacific. Recently, there have been several studies that have indicated significant variability over other regions of the North Pacific and potential linkages to the Pacific Decadal Oscillation (PDO). Most of these studies have covered a relatively short time frame, examined a relatively small portion of the North Pacific, or considered a limited number of parameters. What is often lacking is an overall picture of North Pacific variability that draws together all of these individual lines of evidence, and looks for coherent patterns that may help us understand the regional significance of this variability, and the possible mechanisms controlling the observed spatial and temporal patterns. This session provided a forum for presentation of new insights into such links between climate change and the carbon cycle as are manifest in the North Pacific, and showcased – in part – results from a synthesis and modeling workshop (co-sponsored by WG 17) that took place in June 2004, in Seattle (U.S.A.).

Summary of presentations

The session (held in the afternoon of October 20 and the morning of October 21) comprised 18 oral presentations (including 2 invited talks) together with a number of posters.

David Karl set the stage with his invited talk where he described the current state of our understanding (or lack thereof) of microbial processes in the North Pacific Subtropical Gyre, and pointed out a major challenge to go from our picture of a complex microbial food web to a

quantitative understanding of the regional carbon cycle.

The second invited talk by Nicolas Gruber summarized a number of highlights from a June 2004 NOAA Workshop on *Understanding North Pacific carbon-cycle change: Data synthesis and modeling* (co-sponsored by PICES and GCP). The emphasis of this talk was the need to change our image of the North Pacific carbon cycle from a simple steady-state view to a time-varying picture linked (perhaps?) to climate forcing by periodic phenomena such as the Pacific Decadal Oscillation (PDO), as well as the global warming signal that seems to be manifesting itself in a variety of datasets.

A large number of the presentations at the session and most of the associated posters were also related to this June workshop. There were papers showing clear evidence of the interannual and decadal scale variability – though with differing regional trends – in observations of chemical distributions such as $p(\text{CO}_2)$, total dissolved inorganic carbon, and oxygen concentrations at locations all around the North and Equatorial Pacific, and there were other papers trying to make sense of such observations in the context of models of varying complexity (with regard both to the mixing and ecological parameterizations). It is apparent that there is still a lot to be done with regard to integrating the wide variety of observations into a coherent picture, but a start has now been made in doing so. Some of the difficulties brought to light involve deconvolution of changes due to simple physical forcing, and those that may be concomitant on changes in ocean ecology (which may themselves be a response to changes in physical forcing!). As we seek to attribute causes this will assume an ever-greater significance in the future.

In addition to the papers based on the June Workshop, there were a number of other contributions. Two of these presented the recent Sub-arctic Ecosystem Response Iron Enhancement Study (SERIES), one from a more observational perspective, the second with a simple ecological-based model set in the context of simple representation of the mixing that was believed to occur in the experiment. Another

group of papers presented a variety of interesting observations in North Pacific marginal seas and coastal environments which show that these too show interannual and decadal variability that may, ultimately be linked to climate change. There was also an interesting presentation about a new joint Russian/US project (RUSALCA) aimed at documenting climate-induced changes in the Arctic.

List of papers

Oral presentations

David M. Karl (Invited)

Microbial biogeochemical processes in the North Pacific Subtropical Gyre

C.S. Wong, Shau-King Emmy Wong and Yukihiro Nojiri

Carbon change during SERIES (Sub-arctic Ecosystem Response Iron Enhancement Study)

Debby Ianson, Christoph Voelker and Ken Denman

Modelled carbon fluxes in the NE Pacific SERIES iron fertilization experiment

James Christian

Modelling the impact of climate change on the carbon cycle: Redfield and non-Redfield models

Nicolas Gruber, Christopher L. Sabine, Richard A. Feely, Scott C. Doney, Robert M. Key, Jorge L. Sarmiento, Alexander Kozyr and the workshop participants (Invited)

Interannual to decadal variability in the carbon cycle and biogeochemistry of the North Pacific - Highlights from the NOAA/GCP/PICES synthesis and modeling workshop

Sabine Mecking, Mark J. Warner and John L. Bullister

Age and AOU increases at the North Pacific subtropical-subpolar gyre boundary

Hernan E. Garcia, Tim Boyer, Syd Levitus, Ricardo Locarnini and John Antonov

Oxygen and Apparent Oxygen Utilization content variability in the upper North Pacific Ocean (1955 to 1998)

Curtis Deutsch, Steven Emerson and Luanne Thompson

Attributing the causes of North Pacific oxygen changes

Terry E. Whitedge, Kathleen Crane, Vladimir Smolin, Kevin R. Wood and Mikhail Zhdanov

Initial results of Russian-American Long-term Census of the Arctic (RUSALCA) Expedition: 2004

Keith B. Rodgers, Richard A. Feely, Olivier Aumont, James Orr, Gurvan Madec, Nicolas Metzl, Raghu Murtugudde, Patrick Wetzel, Ernst Maier-Reimer, Corinne Le Quere, Eric Buitenhuis, Fei Chai, Galen McKinley, Yasuhiro Yamanaka, Holger Brix, Nicolas Gruber, Taro Takahashi, Rik Wanninkhof, Hisayuki Y. Inoue and Masao Ishii

Interannual to decadal variability in Equatorial Pacific pCO₂ and surface CO₂ fluxes: An intermodel comparison

Richard A. Feely, C. L. Sabine, R. Wanninkhof, A. Murata, R. Key, C. Winn, M. F. Lamb and D. Greeley

Decadal changes of CO₂ in the North Pacific Ocean

Hisayuki Y. Inoue, Masao Ishii, Takashi Midorikawa, Akihiko Murata and Kazuhiro Nemoto

Variations and distributions of pCO₂^{sw} in the western North Pacific during 1990 to 2003

Fei Chai, Lei Shi, Mingshun Jiang, Tsung-Hung Peng and Yi Chao

Modeling decadal variability of carbon cycle in the Pacific Ocean

Chen-Tung Arthur Chen, Shu-Lun Wang, Wen-Chen Chou and David D. Sheu

Carbonate chemistry of the South China Sea

Andrey G. Andreev, C.-T. A. Chen and Nataliya Sereda

Increases in calcium and total alkalinity in the Bering and Chukchi Seas

Jeong-Hee Shim, Young-Chul Kang, Dong-Seon Kim, Jae-Hak Lee and Chul-Ho Kim

Seasonal change in surface pCO₂ distribution in the East China Sea

Kathryn E. Fagan, Fred T. Mackenzie, Daniel W. Sadler and Justin Dilg

Processes controlling air-sea exchange of carbon dioxide, Kaneohe Bay, Oahu, Hawaii

Geun-Ha Park, Kitack Lee, Kyung-Ryul Kim and Dong-Jin Kang

What controls the uptake of atmospheric CO₂ by the well-ventilated East/Japan Sea?

Posters

Andrey G. Andreev and Viktoria Baturina

Interannual variability of dissolved oxygen and inorganic carbon in the Kuril Basin of the Okhotsk Sea

Masao Ishii, Shu Saito, Takeshi Kawano, Kazuhiko Matsumoto, Kazuhiro Nemoto, Hitomi Kamiya, Takashi Midorikawa and Hisayuki Y. Inoue

Decadal trend of the oceanic CO₂ in the western equatorial Pacific warm pool

Shu Saito, Masao Ishii, Hidekazu Matsueda, Keizo Shutta, Masahiko Fujimura, Ikuo Kaneko and Takashi Midorikawa

Change in total inorganic carbon and dissolved oxygen along the 137°E meridian between 1994 and 2003

Kazuhiro Nemoto, Takashi Midorikawa, Hitomi Kamiya, Masao Ishii, Hidekazu Matsueda and Hisayuki Y. Inoue

Long-term trend and interannual variations of winter oceanic pCO₂ and air-sea CO₂ flux in the western North Pacific

Christopher L. Sabine, Richard A. Feely, Nicolas Gruber, Robert M. Key, Kitack Lee, John L. Bullister, Rik Wanninkhof, C.S. Wong, Douglas W.R. Wallace, Bronte Tilbrook, Frank J. Millero, Tsung-Hung Peng, Alexander Kozyr, Tsueno Ono and Aida F. Rios

The oceanic sink for anthropogenic CO₂

Daniel W. Sadler

CO₂ is HOT: Fifteen years quantifying carbon dioxide in the subtropical Pacific Ocean

Takayuki Tokieda and Masao Ishii

Variability in the degree of saturation for CFCs in the North Pacific Central Mode Water

Nobuo Tsurushima, Yutaka W. Watanabe, Yukihiko Nojiri and Koh Harada

Temporal and spatial variation of dissolved inorganic carbon in the western North Pacific in recent years

CCCC Topic Session (S9)

The impacts of large-scale climate change on North Pacific marine ecosystems

Co-Convenors: Harold P. Batchelder (U.S.A.), William R. Crawford (Canada), Michael J. Dagg (U.S.A.) and Suam Kim (Korea)

Background

Although it is widely known from the fossil record of deep-sea cores that climate changes on the glacial-interglacial scale generate significant impacts on marine ecosystem productivity and structure, it is only in the last ten to fifteen years that marine scientists have begun to document evidence that basin- or large-scale climate changes might be significant forcing for decadal to millennium-scale changes in marine ecosystems. Tidbits of information led to the development of the Global Ocean Ecosystems Dynamics (GLOBEC) projects of many individual nations, and to several regional scale programs examining the influence of climate change. In 1994, PICES initiated the Climate Change and Carrying Capacity (CCCC) Program to provide an organizational framework for examining climate impacts on marine ecosystems in the North Pacific. During the past decade, the North Pacific experienced the strong 1997 El Niño and 1998 La Niña, as well,

perhaps, as a regime shift in the late 1990s. The purpose of this session is to begin a general synthesis of these studies linking climate change to ecosystem productivity and structure in the North Pacific Ocean.

Many national programs examining climate-ecosystem linkages on a regional scale are nearing conclusion, and will benefit from the grander scale, basin-wide synthesis that will be initiated in this session. This session brought together scientists from different regions of the Pacific to share their results, and to encourage collaborations for the broader synthesis that will be the topic of a PICES Symposium planned for April 2006.

Summary of presentations

The session consisted of 25 oral presentations plus nearly 20 posters. The first six presentors summarized GLOBEC or GLOBEC-like studies from each of the PICES member nations.

Harold Batchelder summarized the **U.S.** GLOBEC program that has been occurring in the Northeast Pacific since 1997. He highlighted significant new insights on the importance of meso-scale eddies in effecting cross-shelf transport of water, nutrients and organisms, the role of flow-topography interactions in structuring spatial patterns of productivity and ecosystem structure in coastal ecosystems, and the role of far field forcing and phenomena (large scale wind patterns) on transporting different water masses and their impacts in local regions.

Ian Perry described the **Canadian** GLOBEC program that was conducted from 1996-2001. The lifespan of Canadian GLOBEC academic funding was short, but it led to many ongoing "GLOBEC-like" efforts, including a sustained time-series sampling on the Vancouver Island shelf, studies of zooplankton aggregations near abrupt topographic features, and continued model development for both basin and shelf ecosystems.

Because Russia has had no formal GLOBEC program, Vladimir Radchenko instead reviewed the various **Russian** activities that contributed to GLOBEC International and other IGBP activities (*e.g.*, PAGES, SOLAS). He described the development of several database efforts (global atlas of ocean waves; database of world ocean bioluminescence). Lastly, he highlighted the important contributions of Russian scientists in developing a comprehensive metadatabase of biological data collected by Russian fisheries research institutes.

Yoshioki Oozeki presented progress made in several GLOBEC or GLOBEC-like projects within **Japan**. He briefly introduced the goals and some results from the BIO-COSMOS, VENFISH, FRECS and DEEP projects. Each of these projects had (or will have: DEEP is just beginning) substantial field and modelling components. The projects differ principally in their target species and the key physical forcing involved. For example, BIO-COSMOS focused on Japanese Sardine, VENFISH on Pacific saury and walleye Pollock, FRECS on jack mackerel and Japanese common squid, and DEEP on

interactions between surface pelagic fishes and meso- and bathy-pelagic fishes.

Suam Kim described the activities of **Korea** GLOBEC, which began in 1998. Several major international symposia (in 2000 and 2002) were held to bring scientists together to exchange information about Northwestern Pacific ocean regions and marginal seas, which have subsequently been published. Korea GLOBEC research has focused on ecosystem and biogeochemical processes in the East China and Yellow Seas. Recently, Korea GLOBEC has agreed to support the travel of young Korean scientists to significant international meetings on marine science.

Ling Tong provided an overview of the **Chinese** national GLOBEC program, which has consisted of shelf-sea studies in the Bohai Sea (1997-2000) and the East China Sea (1999-2004). Anchovy spawning and regions of anchovy eggs and young larvae were more controlled by physical features (*e.g.*, fronts) than by trophic (prey distribution) relations. More than 80% of the anchovy eggs were not viable in some surveys.

Thomas Weingartner provided an invited talk on ecosystem structure and function on the Gulf of Alaska (GOA) shelf. It provided an overview of the GOA shelf ecosystem, including seasonal, interannual and interdecadal physical variability and cross-shelf variation in ecosystem structure and production. Mechanisms regulating primary production and energy transfer through the food web to higher trophic levels were described, with evidence of both bottom-up and top-down controls on fish recruitment. Climate change, such as warmer, wetter conditions that might occur in the GOA, could affect the timing and patterns of freshwater runoff and nearshore stratification and have significant ecosystem consequences. Changes in the seasonal pattern or variability of physical forcing that affects mixing and freshwater dispersal might have as large an impact on coastal ecosystems as a change in the mean seasonal state.

Julie Hall provided an overview of the new IGBP Integrated Marine Biogeochemistry and

Ecosystem Research (IMBER) program. She described the four principal themes of IMBER, the implementation of IMBER science, how it relates to and collaborates with other IGBP projects, like GLOBEC, and anticipated outcomes (products) of the IMBER program.

The remaining contributed presentations (both oral and poster) covered a wide range of topics in geographic regions spanning the Pacific, including several basin-wide comparisons of regime shift impacts in the California, Kuroshio and Humboldt current systems. There were several presentations on recent changes in ocean conditions in the California Current System, considerations of why the Bering Sea ecosystem has remained in a warm phase state, and model studies of atmospherically forced wind-driven circulation and their impact on marine ecosystems in the North Pacific since 1990. Many of the talks and posters made connections, some of them indirect, between climate variations and ecosystem or population responses, including studies on zooplankton (abundances, species composition, phenology), many types of fishes, but especially sardines and

salmon (abundances, survival and growth rates), and even coastal kelp forests.

Overall, the session was a resounding success in achieving the goal of communicating the results of recent regional investigations of climate variability and ecosystem impacts to a broader audience of peers conducting similar studies in other regions and perhaps, on different trophic levels of the ecosystem. The goal was to provide a breadth of new information to scientists studying climate-ecosystem interactions in the North Pacific. To that end, the session was successful. It is now up to those scientists to consider what they learned, and to begin the process of multinational, cross-regional scientific collaboration that will lead to basin-scale synthesis and improved understanding of how climate variability impacts marine ecosystems, and how to consider these ecosystem level impacts in managing marine living resources. The broader scale understanding that will be gained by considering multiple regional impacts of large scale forcing will be presented at the CCCC Symposium in April 2006.

List of papers

Oral presentations

Harold P. Batchelder

U.S. GLOBEC: Significant findings of climate variability impacts on marine ecosystems in the Northeast Pacific

Qisheng Tang (delivered by Ling Tong)

The overview of Chinese National GLOBEC Program

Vladimir I. Radchenko

Russia in scientific collaboration in programs related to the GLOBEC International

Yoshioki Oozeki and Hiroaki Saito

Progresses and achievements of GLOBEC research projects in Japan

Im Sang Oh (delivered by Suam Kim)

Korea GLOBEC

David Mackas and Ian Perry

GLOBEC Canada: Results and follow-on activities

Thomas Weingartner (Invited)

Ecosystem structure and function on the Gulf of Alaska shelf

Julie A. Hall

A new international research project: Integrated Marine Biogeochemical and Ecosystem Research (IMBER)

Enrique Curchitser, Dale Haidvogel, Albert Y. Hermann, Elizabeth Dobbins and Thomas Powell

A numerical simulation of large-scale physical events in the North Pacific ocean during the 1997-2003 period

William R. Crawford

The eastern Gulf of Alaska: A 36-year time series along Line-P and implications for biological impact

Adriana Huyer, P. Michael Kosro, Robert L. Smith and Patricia A. Wheeler

Changing ocean conditions in the Northern California Current: 1997-2003

John A. Barth, Brian A. Grantham, Francis Chan, Karina J. Nielsen, David S. Fox, Adriana Huyer, Jane Lubchenco, Bruce A. Menge, Anthony R. Kirincich, Burke Hales and Patricia A. Wheeler

Upwelling-driven inner-shelf hypoxia and its connection to oceanographic changes in the Northeast Pacific

James Overland, Jennifer Boldt, Phyllis Stabeno, Anne Hollowed and George Hunt, Jr.

Is the Bering Sea ecosystem stuck in a warm phase?

William Peterson and Rian Hooff

The climate shift of 1998: Something old or something new?

Sanae Chiba, Hiroya Sugisaki and Toshiro Saino

Decadal scale variation of copepod community structure in the Oyashio based on the Odate Collection

Kazuaki Tadokoro, Hiroya Sugisaki, Hiroaki Saito and Toshiro Saino

Interannual variations in developmental timing of *Neocalanus* copepod populations in the Oyashio waters of western subarctic North Pacific

Jung-Hoon Kang, Woong-Seo Kim, Hae-Jin Jeong and Jae-Hoon Noh

The latitudinal differences of mesozooplankton distribution in the Northeastern Equatorial Pacific under El Niño, La Niña and normal condition

Kenneth O. Coyle

The Optimal Stability Window hypothesis and copepod concentrations on the Gulf of Alaska shelf during spring and summer, 1998 - 2002

Kentaro Morita, Shoko H. Morita and Masaaki Fukuwaka

Population dynamics of Japanese pink salmon: Does climate change explain the recent increasing trend?

Albert J. Hermann, Enrique N. Curchitser, Dale B. Haidvogel and Elizabeth L. Dobbins

A comparison of remote versus local influence of El Niño on the coastal circulation of the Northeast Pacific

Lewis Haldorson, Jack Piccolo and Jennifer Boldt

Effects of marine habitats on growth, condition and survival of juvenile pink salmon in the coastal Gulf of Alaska

Carrie A. Holt and Skip McKinnell

Annual variability in condition factor of sockeye salmon (*Oncorhynchus nerka*) from 1915-1972 in British Columbia, Canada

Tim R. Baumgartner, Guillermo Auad, Hideaki Nakata and Arthur J. Miller

Comparison of the effects of the 1976-77 North Pacific climate shift on the California and Japanese sardine habitats

Juergen Alheit and Andrew Bakun

Comparison of synchronous ecological regime shifts in Humboldt and Kuroshio Currents

Shang Chen and Yoshiro Watanabe

Did regime shift occur in the East China Sea?

Posters

Toby D. Auth and Richard D. Brodeur

Distribution and concentration of ichthyoplankton off the Oregon coast in 2000 and 2002

Rebecca E. Baldwin, Mary Bhuthimethee and Kym C. Jacobson

Comparing macroparasites of juvenile salmon and associated fish collected off the coast of Oregon and northern California

Steven J. Bograd, William R. Crawford, Howard J. Freeland, Adriana Huyer, Jeffrey J. Polovina, Franklin B. Schwing and Robert L. Smith

On the origin and evolution of a "minty" water mass anomaly in the Northeast Pacific

Richard D. Brodeur, Elizabeth A. Daly and Robert A. Schabetsberger

Interannual and interdecadal variability in juvenile salmon diets in relation to environmental changes in the Northern California Current

Alexei I. Pinchuk and Kenneth O. Coyle

Interannual changes in abundance of dominant euphausiids in the northern Gulf of Alaska

Svetlana V. Davidova

Dynamics of the mass pelagic fishes of the Japan/East Sea during the second part of the 20th century and factors responsible for the variation

Svetlana Yu. Glebova

Reorganizations of atmosphere regime over the Far Eastern Seas occurred in 2000-2003

Kym C. Jacobson and Edmundo Casillas

Varying climate-driven ocean conditions and the growth of juvenile salmonids in the California Current system

Julie E. Keister and William T. Peterson

Biological patterns in years of contrasting upwelling-favorable winds

Thomas C. Kline, Jr.

Spatial and temporal variability patterns in the nitrogen and carbon stable isotope composition of sub-arctic Pacific biota during the GLOBEC long-term observational program: Implications for interpreting long-term records

Toru Kobari, Kazuaki Tadokoro, Sanae Chiba, Takashige Sugimoto, Kazuki Kuroda and Naoki Nagai

Interannual variations in diatom abundance during winter and summer in western tropical to subtropical Pacific

Lydia B. Ladah

A coastal ocean monitoring program along the Baja California coastline: Climate change, internal waves and the kelp forest ecosystem

Chung-II Lee, Kyu-Dae Cho and Kwang-Ho Choi

The effects of El Niño events on sea water temperature variation and squid catch in the Korean coastal and off-shore waters

Jae-Bong Lee, Chang-Ik Zhang, Karen-Hyun, Suam Kim and Dong-Woo Lee

Spatio-temporal distributions of small pelagics around Korean waters using a neural network pattern recognition approach

Vadim V. Navrotsky

Climate, ocean ecosystems, and sustainable fisheries

Akira Nihira and Masakazu Takahashi

Decadal variations of demersal fish populations in relation to climate/oceanic regime shifts in the waters off the northeast coast of Japan

Thomas C. Royer, Chester E. Grosch, Thomas J. Weingartner and Seth Danielson

A warmer and fresher Northern Gulf of Alaska?

Amy R. Childers, Terry E. Whitley and Dean A. Stockwell

Seasonal and interannual variability in the distribution and dynamics of nutrients and chlorophyll across the Gulf of Alaska shelf: 1998-2000

CCCC/MODEL Topic Session (S10)

Modeling approaches that integrate multiple spatial scales and trophic levels between shelf and open oceans

Co-Convenors: Shin-ichi Ito (Japan), Michio J. Kishi (Japan), Bernard A. Megrey (U.S.A.) and Francisco E. Werner (U.S.A.)

Background

Marine ecosystems are characterized by complex trophic interactions that occur on disparate time and space scales. Modulation by physical and biogeochemical properties further complicate these interactions. To date, most studies of marine ecosystems consider shelf and open ocean regions separately. However, through active migration and/or advective processes, shelf and oceanic populations are coupled. This session invited contributions that consider various domains that integrate across multiple spatial scales, temporal scales and trophic levels, with objective to develop a better understanding of how open ocean and shelf ecosystems are linked.

Summary of presentations

The session was rich in exchanges and discussions with significant advances in physical

and biological modeling approaches and results described. The findings presented showed quantitative and realistic (when compared to field data) descriptions of complex processes spanning multiple physical scales and biological (trophic) levels. Several efforts identified processes of cross-shelf exchange induced by the interaction of offshore currents with shelf regions. Examples included the Kuroshio off the East China Sea and the Alaskan Stream in the Central Gulf of Alaska. It was clear that the source-regions onto the shelf were spatially three-dimensional and temporally variable. The effects of these currents in providing nutrients to the shelf and the implications to the shelf ecosystems, from primary producers to upper trophic levels, were evident. Regional scale models quantified the effect of smaller scale dynamics (and likely associated enhanced mixing) generated by instabilities in the flow and from interactions of the current with bottom topographic features. At the same time, it

became clear that we are gaining new understanding of the role of nutrients other than nitrogen, in particular phosphorous, in determining the biological processes in the shelf regions.

At basin scales, exciting results were presented of long-term simulations of the North Pacific Ocean from 1947-2000. The model results captured and offered possible explanations to many of the signals believed to be related to the observed regime shift of the mid-1970s. The importance of this result is that variations at basin scales in offshore regions are impressed upon the shelves. Without these basin-scale advances, progress in understanding the local (shelf-scale) responses is not possible.

Results from upper trophic models that considered interannual variability of Pacific saury growth using NEMURO.FISH and larval Pollock recruitment using an individual-based model formulation were presented. The results identified important successes as well as areas of

future work. In particular, it was shown that knowledge of larval mortality is necessary to achieve quantitative recruitment forecasts (in the Pollock case), and additional detail in hydrographic features such as freshwater sources (in the saury case) is necessary to capture the stability of the water column needed to properly specify the production of the (lower trophic) prey for saury. A study of an individual based model of copepods off the US west coast suggested that interannual variability in upper water column conditions may lead to mismatches between the timing of copepod re-emergence and subsequent growth of the zooplankton population. Implications of such mismatches to the location and timing of the zooplankton to its predators (*e.g.*, salmon smolt) was discussed.

In summary, the session presented state of the art modeling studies of coupled physical and biological processes in the study of marine ecosystems. Future directions and necessary areas of research were outlined.

List of papers

Oral presentations

Xinyu Guo, Yasumasa Miyazawa and Toshio Yamagata (Invited)

Intrusion of Kuroshio water onto the continental shelf in the East China Sea and its influences on the ecosystem

Jian Su and Lai-Ah Wong

A three-dimensional numerical study of the spirals and water exchange near the shelf front in the northern South China Sea in winter

Tian Tian, Hao Wei, Jian Su and Chang-Soo Chung

Simulations of annual cycle of phytoplankton production and the utilization of nitrogen in the Yellow Sea

Maki N. Aita, Yasuhiro Yamanaka and Michio J. Kishi

Interdecadal variation of lower trophic ecosystems in the Northern Pacific between 1948 and 2002, using a 3-D physical-NEMURO coupled model

Shin-Ichi Ito, Michio J. Kishi, Daiki Mukai, Yutaka Kurita, Yasuhiro Ueno, Yasuhiro Yamanaka, Bernard A. Megrey and Francisco E. Werner

A study for interannual variability of Pacific saury using a simple 3-box model of NEMURO.FISH

Albert J. Hermann, Sarah Hinckley, Elizabeth L. Dobbins and Dale B. Haidvogel

Quantifying cross-shelf and vertical nutrient flux in the Gulf of Alaska with a spatially nested, coupled biophysical model

Carolina Parada and Sarah Hinckley

A biophysical model for walleye pollock in the Gulf of Alaska to study recruitment variability: A coupled modelling approach

Andrew W. Leising

The effects of seasonal variability on copepod overwintering and population success: The match-mismatch of zooplankton and phytoplankton

Posters

Irina V. Ishmukova

Assessing the quality of marine ecosystem models

Daiki Mukai, Fei Chai and Michio J. Kishi

Modeling interannual and decadal variability of Pacific saury

Annette Samuelsen and James J. O'Brien

Influence of energetic meso-scale eddies on the lower trophic levels of the ecosystem in the northeastern tropical Pacific

TCODE E-POSTER Session (S11)

Data visualization of open ocean processes in the North Pacific

Co-Convenors: Mark Merrifield (U.S.A.), Thomas C. Royer (U.S.A.) and Igor Shevchenko (Russia)

Background

Based on the theme of open ocean processes, this session provided opportunities to present technologies that animate remotely sensed data such as TOPEX/Poseidon/Jason altimetry, SeaWiFS and MODIS ocean color and sea surface temperature measurements. The integration of remotely sensed physical, biological and chemical data was encouraged especially with regard to oceanic “hot spots” of biological activity. With the further development of global integrated data bases for handling various classes of data applicable to the PICES region, discussions of techniques of data retrieval and archiving were very timely.

Summary of presentations

The session consisted of 5 presentations. There were two papers describing the manipulation of large, diverse data sets such as GIS (Golik *et al.* and Kaplunenko, *et al.*) that demonstrate interests of young researchers on dealing with the next generation of data and data handling software such as Virtual Database (VDB). Igor

Shevchenko *et al.* presented systems that can deal with the updating and retrieval of data from distributed metadata sets. Peter Etnoyer illustrated the identification of “hot spots” and persistent marine habitats through the manipulation of remotely sensed sea surface temperatures and catch data. He found an important, persistent habitat for blue whales, swordfish and striped marlin off Baja California. Zainuddin *et al.* used basin wide remotely sensed data sets (sea surface temperature, chlorophyll and sea surface height) to provide information on the distribution of albacore tuna. Using a multilayered approach, they found that the tuna responded to “hot spots” created by ocean eddies where biological productivity was enhanced.

While the session began with relatively low attendance (possibly as a function of its relative remoteness to food and drink), at the end of the poster session many individuals were present. The session was extended well beyond the scheduled closing time and was finally terminated when the staff turned off the lights.

List of E-posters

Peter Etnoyer (Invited)

Visualizing pelagic habitat in the Northeast Pacific

Andrew V. Golik and Vitaly K. Fischenko

The technologies of integration of the oceanographic data, tools of their visualization and analysis in internet-based GIS

Dmitry D. Kaplunenko, Young J. Ro , Vyacheslav B. Lobanov and Eung Kim

Development of web-based technology for composing comprehensive oceanographic data sets of the East/Japan Sea

Igor Shevchenko, Georgy Moiseenko and Olga Vasik

Using Marine Biology ontology for metadata exchange

Mukti Zainuddin, Katsuya Saitoh and Sei-ichi Saitoh

Spatio-temporal dynamics of albacore fishing ground and environmental conditions detected by remotely sensed satellite data

BIO Paper Session (BIO)

Convenor: Vladimir I. Radchenko (Russia)

Background

The BIO Committee's area of responsibility is to promote and coordinate biological oceanography and interdisciplinary research in the northern North Pacific. The Committee has an enormous mandate: at the organisms' scale - from microbes to marine mammals and birds, and among associated scientific disciplines - from physical oceanography issues in their effect on different trophic levels of marine biota to marine environmental quality fields related to the harmful algal bloom (HAB), contaminant cycles in food webs, *etc.* In order not to exclude important tendencies arising in contemporary biological oceanography with the traditional practice of only specified topic sessions during the PICES Annual Meetings, papers on all aspects of biological oceanography in the North Pacific and its marginal seas were invited for the BIO Paper Session. The session highlights new research approaches and elucidates promising scientific hypotheses and directions in the biological oceanography developments. The session also reveals up-to-date tendencies in biological oceanography in the North Pacific, and allows the designating of the most topical themes for future BIO Committee activity and efforts that are stated in the approved PICES Strategic Plan.

Summary of presentations

The session consisted of 6 (from the planned eight) oral presentations plus 9 posters. Four papers dealt with diverse aspects of zooplankton ecology: community and population structure, productivity and metabolic characteristics. Four talks and posters were devoted to fish species, including saury and sardine-iwashi stock dynamics, pelagic fish larvae distribution, and flatfish age determination. Three posters dealt with phytoplankton issues, two of them specifically with HAB, namely with the harmful dinoflagellate species detection and dinoflagellate cysts distribution in the Yellow Sea. Two Russian papers were on studies of

benthos community structure and distribution in the Peter the Great Bay and north-eastern Sakhalin shelf areas. Acoustic visualization of vertical biota distribution and site-specific factors affecting reproduction of colonial sea birds were topics for two other presentations. Two scheduled but not presented (due to presenter absence) talks were devoted to the contamination monitoring in the fish body and trophic ecology of micronektonic crustacean assemblages.

Among studied characteristics, quantitative distribution and, rarer, community structure were among the main objects in ten presented studies. New details were found in the vertical distribution of oncaeid copepods, micronektonic crustaceans, and larger nektonic animals as fish and baleen whales. Marine birds' colony distribution with respect to the variety of marine habitats affects their nesting success through the bottom-up, top-down, timing mismatch and colony-specific factors. Chlorophyll, zooplankton and fish distribution appear to be closely related to the vertical and horizontal water mass structure. Fine methods of investigation were presented in the studies of molecular population structure of euphausiids, metabolic rate measurements for copepod, harmful dinoflagellate species detection, and the biological effect of contamination in common benthic fish species. Two talks were devoted to fish stock fluctuations in relation with climate change and oceanographic regime shifts. Age determination using otoliths structure can be considered as routine ichthyologic procedure, however, it allows clarification of the age structure of two tropical flatfish species and has important consequences for fishery management.

The beginning of the session was not well attended due to an overlap with the popular CCCC Topic Session. However, the Committee would like to emphasize that most presentations at the BIO Paper Session were made by young scientists. Paper sessions with more general

topics can serve as a suitable mechanism for young scientist involvement at the PICES Annual Meetings and activities. Avoidance of

time conflict with another major session would be desirable.

List of papers

Oral presentations

Kaoru Nakata, Hiroshi Itoh, Kiyo Kurita and Hiroshi Kiyosawa

Seasonality in the oncaeid copepods in the epipelagic layers of the subtropical water off Kuroshio

Hye-Seon Kim, Ho-Young Soh, Yang-Ho Yoon, Doo-Jin Hwang and Sang-Duk Choi

Molecular population structure of the euphausiid *Pseudeuphausia sinica* from the Northeastern Asia

Vitali Dudarev and Vadim Savinikh

On the fluctuations of sardine-iwashi abundance

Alexey A. Baytalyuk and Vadim F. Savinykh

Abundance dynamics of pacific saury (*Cololabis saira*) in the northwestern Pacific Ocean

Felipe Amezcua, Ivan Martínez-Tovar and Yanira Green

Use of otoliths to determine the age and growth of two subtropical flatfishes, *Cyclopsetta querna*, and *Cyclopsetta panamensis* (Pleuronectiformes: Paralichthyidae), off the southeast coast of the Gulf of California, Mexico

Robert Suryan, David Irons, Evelyn Brown, Patrick Jodice and Daniel Roby

Site-specific factors affecting productivity of an upper trophic level marine predator: Bottom-up, top-down, and mismatch effects on reproduction in a colonial seabird

Posters

Tatyana A. Belan, Elena V. Oleynik, Valentina D. Budaeva, Luisa N. Propp, Marina S. Selina, Vyacheslav G. Makarov and Ludmila S. Belan

Productivity of pelagic communities and distribution patterns of benthos on the continental shelf and slope of the Okhotsk Sea along NE Sakhalin Island

Eun-Seob Cho

PCR-based assays for detecting ichthyotoxic *Cochlodinium polykrikoides* (Gymnodiniales, Dinophyceae) in the South Sea of Korea

Hung-Yen Hsieh, Wen-Tseng Lo, Don-Chung Liu and Wei-Cheng Su

Spatial distribution of fish larvae in relation to hydrographic conditions in the waters around Taiwan

Morio Ichihara, Kazushi Miyashita, Hiroto Murase, Hikaru Watanabe and Shigeyuki Kawahara

Acoustic visualization of the relationship between ocean structure and the vertical distribution of biota in the Kuroshio-Oyashio Transition Zone (KOTZ)

Tsutomu Ikeda, Fumikazu Sano and Atsushi Yamaguchi

Metabolic characteristics of meso- and bathypelagic copepods in the Oyashio region, western North Pacific Ocean

Sam Geon Lee and Seung Heo

The distribution of modern dinoflagellate cysts in the Yellow Sea

Vladimir I. Dulepov and Natalia N. Lelyukh

Study of macrobenthos communities in Peter the Great Bay using an underwater vehicle

Akihiro Shiomoto, Kosei Sasaoka, Mitsuhiro Toratani and Shinji Hashimoto

Relatively high chlorophyll *a* spots in the offshore subarctic North Pacific in summer

FIS Paper Session (FIS)

Convenor: Yukimasa Ishida (Japan)

Background

Fishery science in PICES has a broad field due not only to its species diversity, but also the wide geographical range in the North Pacific

Ocean. Therefore, a specific topic session sometimes does not cover the need of fisheries scientists of PICES member countries. At the FIS meeting at PICES XI (2002), it was noted that there was no FIS Paper Session, and it was

pointed out that convening such a session at PICES XII would enhance FIS activities in PICES and allow participation by more fisheries scientists with different interests. The FIS Paper Session is also a good way to keep opportunities open for students to give presentations. These ideas were also confirmed at the FIS meeting at PICES XIII (2004). The FIS Paper Session in 2004 received 36 papers on various fishery species, submitted by scientists including some from non-PICES countries.

Summary of presentations

The session consisted of 12 oral presentations plus 24 posters. The first half of the session consisted of various topics such as recruitment process of small pelagic fish, analysis fish by-catch, and impact of global change on fisheries resources of a coastal ecosystem. The Kuroshio Current and its branch transport a large amount of the egg of Japanese jack mackerel, and larvae spawned and hatched in the southern East China Sea, north-eastward into the nursery grounds off southern Japan. The relationship between the abundance of small larvae and juveniles suggested that larval survival highly fluctuates

List of papers

Oral presentations

Chiuyuki Sassa and Yoshinobu Konishi

Recruitment process of the Japanese jack mackerel in the East China Sea (ECS) - Spawning ground and larval transport into fishing grounds

Motomitsu Takahashi, Yoshiro Watanabe, Hiroshi Nishida and Akihiko Yatsu

Interannual variation in growth of larval and early juvenile Japanese anchovy in the Kuroshio-Oyashio transition region

Ivan Martinez Tovar, Felipe Amezcua Martinez and Juan Madrid Vera

Analysis of fish bycatch from the commercial shrimp fleet in the Southeast Gulf of California

Ling Tong and Qisheng Tang

Impacts of global change on fisheries resources of a coastal ecosystem

Hiroshige Tanaka, Akinori Takasuka, Ichiro Aoki, Seiji Ohshimo and Yoza Wada

Geographical variations in carbon and nitrogen stable isotope ratios of Japanese anchovy *Engraulis japonicus*

Michael J. Schirripa, Jim J. Colbert and Omar Rodriguez

Interannual changes in Pacific hake (*Merluccius productus*) growth in response to oceanographic conditions

Mikhail A. Stepanenko

Environmental differentiation of pollock reproduction in the Bering Sea

Oleg A. Bulatov

Pollock fishery and total allowable catch in the Bering Sea

Tetsuichiro Funamoto, Keizo Yabuki and Satoshi Honda

Temperature-dependent stock-recruitment model for walleye pollock around Hokkaido, Japan

Jennifer P. Stahl and Gordon H. Kruse

Maturation of walleye pollock, *Theragra chalcogramma*, in the eastern Bering Sea in relation to temporal and spatial factors

year to year probably due to wind and current effects. About the impacts of global change of fisheries resources of a coastal ecosystem, indices of primary production, zooplankton biomass and fish productivity were used to describe the ecosystem productivity at different trophic levels. The results indicate that substantial variation in ecosystem productivity is one of the important characteristics of coastal ecosystem dynamics.

The second half of the session consisted of six walleye pollock presentations. Three issues for pollock fishery managements in the Bering Sea were raised, stock structure, the precision of stock assessment methods, and the magnitude of the exploitation rate. The diet of juvenile walleye pollock analysis revealed that seasonal variation in juvenile pollock diet and condition exists, but its effect on nutritional stress, and perhaps fish survival during winter, might be tempered by geographic variation in prey resources. Stock-recruitment relationship for Japanese local pollock stocks were examined and suggested that the recruitments are affected by sea surface temperature rather than density dependent factors.

Yong-Woo Lee, Bernard A. Megrey and S. Allen Macklin

Predictability of future recruitment by parametric and non-parametric models: Case study of Gulf of Alaska walleye pollock

Andre Buchheister and Matthew T. Wilson

Differential food habits as a mechanism for seasonal and geographic variation in juvenile walleye pollock condition in the western Gulf of Alaska

Posters

Felipe Amezcua, Juan Madrid and Hugo Aguirre

Effect of the artisanal shrimp fishery on the ichthyofauna in a subtropical coastal lagoon in the Gulf of California

Alexander V. Buslov and Oleg B. Tepnin

New data on walleye pollock spawning in waters of the Commander's Islands Preserve

Elena Dulepova

Trophic relations of chum (*Oncorhynchus keta*) and pink salmon (*O. gorbuscha*) in the western Bering Sea

Yukimasa Ishida, Tomonori Azumaya, Masaaki Fukuwaka and Toru Nagasawa

Estimation of catch efficiency of salmon gillnets, distance traveled by salmon, and salmon density in the Bering Sea

Nozomi Ishiko, Hidetada Kiyofuji and Sei-Ichi Saitoh

Prediction of Pacific saury fishing grounds based on physical variability derived from daily satellite remote sensing data

Eun-Jung Kim, Suam Kim, Dae-Yeon Moon and Jeong-Rack Koh

The variations in distribution, catch, and biology of skipjack tuna (*Katsuwonus pelamis*) induced by climate variability

Hee-Yong Kim, Atsushi Kaneda, Taisuke Inai, Xinyu Guo and Hidetaka Takeoka

Effect of the Kuroshio frontal eddy on the recruitment of jack mackerel larvae and juveniles in the Bungo Channel, Shikoku, Japan

Sergey G. Korostelev and P.M. Vasilets

Changes in the composition of demersal fish communities on the western Kamchatka shelf under the influence of fishing

Sergey V. Loboda and Pavel V. Vorobyov

Influence of commercial fishing on the stock conditions of Pacific herring from the northern part of the Okhotsk Sea

Ole A. Mathisen and Lowell Fair

Density dependent growth of sockeye salmon in the ocean

Alexander Nikolaev and Michail Kuznetsov

Acoustic methods for monitoring and ecosystem studies in the Bering and Okhotsk Seas

Todd Sandell, Kym Jacobson, David Teel and Edmundo Casillas

The distribution and prevalence of Bacterial Kidney Disease (*Renibacterium salmoninarum*) in juvenile chinook and coho salmon in the Northeast Pacific Ocean

Anatoly V. Smirnov

Environmental impact of interannual variability of Okhotsk Sea pollock abundance

Gennady V. Avdeev, Anatoly V. Smirnov, Evgeny E. Ovsyannikov and Svetlana L. Ovsyannikova

Variability in sex ratio of the northern Okhotsk Sea walleye pollock spawning stock in 1997-2002

Katsuya Suzuki, Tsutomu Takagi, Shinsuke Torisawa and Kazushi Miyashita

Video analysis of the schooling behavior of Japanese surfmelt (*Hypomesus japonicus*) under light and dark conditions using a mathematical model

Andrey V. Vinnikov, Dmitry A. Terentiev, Alexei M. Tokranov and Boris A. Sheiko

The preliminary estimation of abundance of some fishes in adjacent waters of the Commander Islands by results of bottom long-line catching in 1995-1997

Songguang Xie and Yoshiro Watanabe

Hatch-date dependent difference in growth and development of jack mackerel *Trachurus japonicus* during early life stages recorded in otolith microstructure

Songguang Xie, Yoshiro Watanabe, Toshiro Saruwatari, Reiji Masuda, Yoh Yamashita, Chiyuki Sassa and Yoshinobu Konishi

Growth and morphological development of sagittal otolith of jack mackerel *Trachurus japonicus* in larval and early juvenile stages

Chang Ik Zhang, Jae Bong Lee and In-Ja Yeon

Current status of ecosystem-based fisheries management in Korea

CCCC/REX Workshop (W2)

The seasonal cycle of plankton production in continental shelf waters around the Pacific Rim

Co-Convenors: Kaoru Nakata (Japan) and William T. Peterson (U.S.A.)

Background

The REX Task Team has the responsibility of developing inter-comparisons among regional coastal marine ecosystems. For PICES XIII, REX proposed a comparison of the seasonal cycles of plankton production at sites around the Pacific Rim. Given that a long-term goal of the CCCC Program is the application of models to understanding the influence of climate variability on plankton and fish production in the North Pacific, a near term goal is to learn more about (a) the influence of climate variability on plankton production cycles, and (b) to determine if we can model the seasonal cycle of plankton production with the NEMURO model in many sites around the Pacific Rim.

We need to locate as many site-specific studies as possible that have several years of observations on as many "boxes" in the NEMURO model as possible in order to facilitate model verification studies at some point in the future. Since NEMURO is an NPZ model, successful model-data comparisons will require data on temporal changes in light, nutrients, phytoplankton, and zooplankton over (ideally) several seasonal cycles. Although the long-term goal of the workshop was to facilitate model-data comparisons at many sites around the Pacific Rim (including the Bering Sea), the proximate goal was to discuss linkages and time lags between primary and secondary production cycles, and where possible, the potential match-mismatch between phytoplankton and zooplankton biomass cycles and the spawning and growth of important fish species.

Summary of presentations

The workshop was convened on Thursday, October 14, 2004. At least 43 were present, with most participants attending the full day. The workshop was opened with a few brief remarks from William Peterson, followed by a presentation from Francisco Werner, an

overview of results from the APN/PICES modeling workshop that was held October 10-13, 2004. The participants were reminded of the efforts within the MODEL Task Team to incorporate geographic variations in the growth of fish, especially on herring, into the NEMURO model.

The opening talk was an invited presentation by Yasuhiro Yamanaka. He reviewed the work of his group on the development of e-NEMURO (extended-NEMURO). The original NEMURO model was developed for sub-arctic ecosystems; the "e" means that the model has now been "extended" to include sub-tropical ecosystems. In addition, NEMURO was coupled to a 3-D circulation model which produces interesting (and perhaps even realistic) projections of the impact of climate change on ecosystem structure in the western Pacific. The model focused on phytoplankton, and predicts an earlier spring bloom as well as the co-existence of both subarctic and subtropical species. The suggestion was made that perhaps e-NEMURO could be viewed as an analogue to Dynamic Vegetation Models that are popular in terrestrial ecosystems.

Hiromi Kasai followed with a discussion of the variability and timing of the spring bloom in Oyashio waters through analysis of the A-Line database. Monitoring of the A-Line (Akkeshi Line) off Hokkaido has been done since 1990, and most of the data are freely available on line. Kasai compared the data from 1990-1997 to 1998-2003 to test the hypothesis that a regime shift occurred in 1998 that was detectable in the Oyashio. The recent period has lower nitrate concentrations, higher phytoplankton in spring and autumn, and higher zooplankton in spring but not autumn, and increased stratification in summer.

Atsushi Yamaguchi discussed interannual variations in seasonal timing of the recruitment of the larger copepods (Metridia, Neocalanus,

Eucalanus) at Site-H (off Hokkaido), based on sampling in 1996-1997 and 2002-2004. *Metridia pacifica* had two recruitment periods per year, whereas all other species had one recruitment period. *N. cristatus* recruit in winter, *N. flemingerii* in March and *N. plumchrus* and *E. bungii* in May. In 2003, a salp bloom associated with a warm core ring affected the recruitment of *N. plumchrus* and *E. bungii*, but not the other species.

Kaoru Nakata discussed seasonal differences in plankton community structure in the subtropical waters of the Kuroshio along the O-Line (Cape Omaezaki) off Honshu Island. Her work is part of a new 5-year study, initiated in 2002, that is looking at the impact of climate variability on planktonic ecosystems in Japanese waters. She found that pico-size eukaryotic phytoplankton dominated in winter, centric diatoms were always uncommon, heterotrophic nano flagellates and ciliates were most abundant in spring and lowest in autumn. Small copepods showed no seasonal cycle; larger copepods had lowest biomass in summer but somewhat higher in autumn through spring.

Toru Kobari presented a similar study, on seasonal changes in plankton biomass, production and community structure from pico- to mesoplankton samples collected monthly to bimonthly, at a coastal site off southern Japan off Kyushu Island. Bacteria, autotrophic nano-flagellates (ANF) and copepods dominated plankton biomass throughout the year, however, there were no seasonal variations in phytoplankton and zooplankton biomass. Kobari presented a box model of the plankton dynamics that was clearly ready to be tested with a NEMURO-like model. He concluded that his study site was probably influenced by advection of coastal waters of low salinity from the East China Sea.

Hyung-Cheol Kim discussed the influence of winds and stratification on seasonality of phytoplankton blooms in the Japan/East Sea. The seasonal dynamics of phytoplankton in the central Japan/East Sea showed pronounced year-to-year variability as observed from SeaWiFS (1997~now) and MODIS/Terra (2000~now).

The authors analyzed the daily remotely-sensed wind stress data (AMI-wind, NSCAT and QuickSCAT: 1997~2003) and daily Chl-a concentration from ocean color data. The results were as follows. In spring, phytoplankton bloom started 6~10 days after the wind weakened. In fall, blooming started 1~4 days after the winds strengthened, which mixes water and supplies nutrients to the euphotic layer.

The first talk after lunch was by our other invited speaker, Young-Shil Kang. She spoke on the variability in seasonal cycles of zooplankton in the seas surrounding the Korean peninsula. Three time periods were compared: 1966-1976, 1977-1988 and 1989-2000. Zooplankton biomass showed a typical seasonal cycle with two peaks in spring and autumn. The waters to the west and south of Korea showed a similar seasonal variation in zooplankton biomass, while waters to the east were different. Zooplankton biomass showed a large peak in February and April during the first time period, only a small peak in October in the second period, but peaks in April and October in the 3rd period (1989-2000). Euphausiids showed peaks in April and October in third period, while a small peak in June in the second period.

Christine Abraham discussed the seasonal cycle of euphausiids in the California Current System from the perspective of a predator, the Cassin's auklet. Relative abundance of euphausiids in the stomachs of these birds was used as an index of relative abundance of krill in the ocean. Off Central California *Euphausia pacifica* were more important in the diet in early spring, whereas in early summer *Thysanoessa spinifera* was most prevalent. During "warm years", *Nyctiphanes simplex* were taken (1993-1995; 1998; 2003). In the southern California Current, *N. simplex* dominated, followed by *T. spinifera* and *Nematoscelis difficilis*. This results seems to match the ecology of these species: *N. simplex* is common in the coastal zone of the South California Current; *T. spinifera* is a coastal species throughout the California Current; *E. pacifica* (a Sub-Arctic species) is more abundant in the North and *N. difficilis* is more abundant in the south.

William Peterson summarized results of his coastal ocean monitoring program centered off Newport, Oregon. Measurements of hydrography, nutrients, chlorophyll and zooplankton biomass and species composition have been made at bi-weekly intervals for nine years, beginning in spring 1996. Climatological seasonal cycles were shown with the result that nitrate concentrations tend to peak in late spring, phytoplankton (as chlorophyll) in June-July and copepod biomass in August and September. There was strong cross-shelf variation in variability of all measurements, with the strongest seasonal cycle in mid-shelf waters. Copepods dominated the zooplankton biomass in shelf waters whereas at the shelf break, euphausiids were usually equal to copepods.

Thomas Wainwright delivered the final talk, on the application of the NEMURO model to the Newport data set presented by Peterson. He coupled NEMURO to a 1-D cross-shelf mixed layer model so as to capture the cross-shelf variations in hydrographic and plankton dynamics. Analyses were conducted over 7 years (1997-2003), and the model was found to be stable over this period. The model simulated well the nitrate and phytoplankton responses at all locations modeled. The model does not reflect the observed spatial distribution of copepods, apparently transporting them offshore too rapidly. Despite this, the model may adequately reflect the seasonal dynamics of copepods when summed across the shelf region. Thus, the model may provide a useful translation of upwelling indices to biological production.

List of papers

Oral presentations

Yasuhiro Yamanaka, Naoki Yoshie, Taketo Hoshioka and Michio J. Kishi (Invited)

Extension of NEMURO to represent habitat segregation of plankton groups in the western North Pacific

Hiroimi Kasai and Tsuneo Ono

Variability in timing and magnitude of the spring bloom in the Oyashio water: An analysis from the "A-line" oceanographic database (1990-2003)

Atsushi Yamaguchi, Tsutomu Ikeda, Toru Kobari, Gadi Padmavati, Satoko Shoden, Sei-ichi Saitoh and Kenshi Kuma

Year-to-year variations in developmental timing of large grazing copepods at Site H in the Oyashio region

Kaoru Nakata, Kiyotaka Hidaka, Yutaka Hiroe, Akihiro Shiomoto, Tomoo Watanabe, Kosei Komatsu, Kiyo Kurita and Hiroshi Kiyosawa

Seasonality in the community structure of planktonic ecosystem in the epipelagic layers of the subtropical water off Kuroshio

Toru Kobari

Seasonal changes in plankton biomass, production and community structure in southern Japan

Hyun-Cheol Kim, Sinjae Yoo and Im-Sang Oh

Relation between phytoplankton blooming and wind stress in the central Japan/East Sea

Young-Shil Kang (Invited)

Variability in seasonal cycles of zooplankton in the seas surrounding the Korean peninsula

Christine L. Abraham, Shaye G. Wolf, J. Mark Hipfner and William J. Sydeman

The seasonal cycle of euphausiid zooplankton in the California Current system: A predator's perspective

William Peterson, Rian Hooff, Leah Feinberg and Tracy Shaw

Seasonal cycle of nutrients, phytoplankton and zooplankton in the coastal upwelling zone off Oregon, U.S.A.

Thomas C. Wainwright, Rian C. Hooff and William T. Peterson

Seasonal dynamics of plankton in the northern California Current ecosystem: A model-data comparison

Posters

Hui Liu, Laura M. Slater, Cheryl Clarke and Russell R. Hopcroft

Growth rates, fecundity and development times of *Neocalanus flemingeri* in the Gulf of Alaska: A synthesis of laboratory and field approaches

Alexei I. Pinchuk and Russell R. Hopcroft

Egg production and early development of *Thysanoessa inermis* and *Euphausia pacifica* (Crustacea: Euphausiacea) in the northern Gulf of Alaska

Hyeon-Gyeong Jeong, Ho-Young Soh, Yang-Ho Yoon and Hae-Lip Suh

Seasonal variation of the neustonic zooplankton community in the central region of the South Sea, Korea

Yeong-Ha Jung, Hyung-Ku Kang and Yong-Joo Kang

In situ egg production rate of the planktonic copepod *Acartia steuerei* in Ilkwang Bay, southeastern coast of Korea

CCCC Workshop (W3)

Linking open ocean and coastal ecosystems II

Co-Convenors: Kerim Aydin (U.S.A.), Shin-ichi Ito (Japan), Jin-Yeong Kim (Korea), Gordon A. McFarlane (Canada) and Akihiko Yatsu (Japan)

Background

This workshop aimed to develop approaches for synthesis of the CCCC Program on the basis of review of ongoing Task Team activities on modeling of lower trophic levels (NEMURO), forage species (NEMURO.FISH) and upper trophic levels (ECOPATH/ECOSIM) on multiple regions of the North Pacific. The workshop consisted of three components:

1. A critical evaluation of regional and basin-wide trophic models with a focus on the recent results of the BASS, MODEL and REX Task Teams. The development of complementary and comparable approaches to: (a) modeling connections between climate and ecosystems, lower and upper trophic levels, and coastal and oceanic regions; and (b) incorporating seasonal dynamics.
2. As a specific example, the examination of climate-driven processes underlying changes in the distribution (expansion and contraction) of Pacific sardines.
3. Identification of the major issues and gaps in knowledge relating to the understanding of changes in ecosystems under a changing environment, and recommendation of how to develop a new Task Team CFAME (Climate Forcing And Marine Ecosystem Response) in collaboration with the MODEL Task Team.

Summary of presentations

The workshop included 9 oral presentations and 3 poster presentations. Kerim Aydin presented results of modeling of subarctic gyres by the BASS Task Team and scope of expansion for

seasonal and geographic linkages. Shin-ichi Ito described results of the MODEL Task Team on coupled lower trophic level - fish models (NEMURO.FISH) applied to Pacific saury and herring. Application of NEMURO to any regions with lower trophic seasonal data became possible by using a calibration software. Expansions of NEMURO to subtropical regions and to a 3-D model are also on-going. The REX Task Team (William Peterson) reviewed the preceded workshop titled "The seasonal cycle of plankton production in continental shelf waters around the Pacific Rim". NEMURO was found effective in the modeling of seasonal variability of lower trophic level.

Kosei Komatsu presented an example of expansion of NEMURO coupled with the Ocean General Circulation Model to Kuroshio and the Kuroshio Extension. Using hake in the California Current as a case study, Vera Agostini concluded that habitat and life history and their links to environment are important in modeling with appropriate geographic scale. Alec MacCall reviewed climate-driven cyclic changes of dominant small pelagic fishes in the California Current and the Kuroshio Current. He also presented the flow hypothesis that a slower current is favorable for three sardine populations in the Pacific.

In the sardine section, Jake Schweigert and Akihiko Yatsu reviewed the biology and population dynamics associated with environmental factors for California sardine and Japanese sardine, respectively. On the basis of otolith daily growth and survival rates of Japanese sardine, Motomitsu Takahashi hypothesized that temperature condition in the

nursery area is critical if prey is sufficient, based on the inverse relation in growth and survival rates of simultaneously collected juveniles of Japanese sardine and anchovy. A modeling approach for sardine life history was thought promising with combinations of 3-D NEMURO.FISH, "individual based model", ECOSIM and possibly age structure models.

Through the discussion, it was concluded that CFAME synthesis projects should 1) begin with a specific testable hypothesis, 2) quantify our state of knowledge on that hypothesis including communication of key uncertainties, 3) recommend sampling/expeditions/symposia/modeling approaches focused on the hypothesis. An overall hypothesis with testable sub-hypotheses were developed for the following CFAME Task Team meeting.

List of papers

Oral presentations

BASS Task Team

Results of upper trophic level ("whole ecosystem") modeling of the subarctic gyres

MODEL Task Team

Results of coupled lower trophic level-fish models (NEMURO-FISH)

REX Task Team

Overview of REX workshop on seasonal cycles of nutrients, phytoplankton and zooplankton and discussion of opportunities for model/data comparisons among coastal ecosystems around the Pacific Rim

Kosei Komatsu (Invited)

Modeling of transportation of phyto- and zooplankton in the Kuroshio and Kuroshio Extension

Vera N. Agostini (Invited)

Modeling the California Current ecosystem: Can the small inform the large?

Alec D. MacCall (Invited)

Climate-driven fluctuations in fish stocks of the California Current

Jake Schweigert

Recent distribution and ecology of sardines in the north-eastern Pacific Ocean

Akihiko Yatsu, Masayuki Noto, Minoru Ishida, Hiroshi Nishida and Maki Suda

A review of the population dynamics of Japanese sardine in the Northwestern Pacific

Motomitsu Takahashi, Hiroshi Nishida and Akihiko Yatsu

Preliminary study of growth of larval and early juvenile Japanese sardine in the Kuroshio-Oyashio transition region

Posters

Shin-ichi Ito, Miciho J. Kishi, Akihiko Yatsu, Yoshioki Oozeki, Kosei Komatsu, Yasuhiro Yamanaka, Bernard A. Megrey and Francisco E. Werner

An application of NEMURO.FISH for multi-species modeling

Jin Yeong Kim, Eun Seob Cho and Woo-Jin Kim

Population genetic characteristics of the Japanese anchovy, *Engraulis japonicus*, in Korean waters

Yury I. Zuenko, Victoria V. Nadtochy and Marina S. Selina

NPZ monitoring in the coastal area of the Japan Sea

PICES/CLIVAR Workshop (W4)

Scale interactions of climate and marine ecosystems

Co-Convenors: Richard J. Beamish (Canada/PICES), Kuh Kim (Korea/PICES) and Kelvin Richards (U.S.A./CLIVAR) and Ichiro Yasuda (Japan/PICES)

Background

The physical climate system varies on a range of scales: changing storminess and severe weather,

recognized modes of variability (such as NAO, PDO and ENSO), and changes to mean global characteristics. Likewise the marine ecosystem has many interacting scales: small-scale

patchiness *versus* regional, shelf *versus* deep-sea populations, and individuals *versus* communities. The goal of the workshop went beyond the current level of physical climate indices/biological population correlations to formulate causal relationships between the changing physical and biological systems, to understand the direction of energy flow and “information,” and to assess the impact of biological “filtering” of long-lived species on climate signals. The workshop brought together experts in the physical oceanography of the Pacific, climate dynamics, marine ecosystems, biogeochemistry and fisheries.

Summary of presentations

The workshop was charged with the task of producing statements on our present understanding, or lack thereof, of the impact of climate variability on the marine eco- and biogeochemical system, on what we can hope to extract from combining extant datasets, and on strategies for numerical experimentation, observational networks and data assimilation that will improve our knowledge and predictive capabilities. There were 20 presentations and structured discussion over the two-day workshop. It was clear from the outset that the charge reached beyond present capabilities, and that what was required was the development of a paradigm and context for addressing such issues; in this regard the workshop was successful. There were examples of physical-biological interactions from throughout PICES waters. These included watermass limits on the west coast of North America, mixing and advection in the Gulf of Alaska, differences in regional ocean productivity in the Bering Sea, and influence of El Niño on frontal structures and productivity in the central Pacific. What was clear is that there exist low-frequency/high-amplitude changes in different marine populations throughout the Pacific, that these changes can often be linked to physical changes, but that they are mediated through different life-history strategies. For example there are *opportunistic* (fast growing,

short lived), *periodic* (slow growing, high fecundity), and *equilibrium* (fast growing, long lived, low fecundity) species. These groups can interact, as an *opportunistic* strategy is to “out run” their controls. Wind stress influences the ocean in two ways, through direct surface transport which influences SST patterns and mixing, and through Ekman Pumping (current divergence) which influences deeper thermocline response. While low-frequency/high-amplitude examples in ecosystems are often referred to as regime shifts, there was debate about its definition in the physical domain. Some supported the concept that white-noise stochastic atmospheric forcing and a one-year ocean memory can create regime-like features in oceanic time series, while others noted physical processes and statistical tests supporting long-memory regime behavior; the nearly one hundred years of record is not long enough to choose between these conceptual models. A. Bakun summarized our situation as “physics legislates and biology finds and exploits loopholes.” A way forward is through “upscaling”. Conceptual or numerical models can develop hypotheses about specific local connections. These processes are linked to regional indicators and then to large-scale physics, *e.g.*, zooplankton to upwelling to ENSO. Once this link is established, the normally long large-scale time series can be used for historical hindcasts or climate models can generate forecast scenarios (downscaling). Integrated Management approaches are going the same route by defining *operational objectives* about an ecosystem, establishing regional indicators and reference points, and establishing monitoring programs on several scales. It was also clear from the workshop that models are becoming major tools, expanding beyond NPZ models, and that satellite data is useful in spanning scales. The connection between CLIVAR and PICES in the North Pacific was fruitful, and future cooperation would be useful for both groups, *e.g.*, evaluation of future climate/ecosystem projections.

List of papers

Oral presentations

Jacquelynne R. King and Gordon A. McFarlane (Invited)

Implications of climate regime shifts on the management of marine resources

Shoshiro Minobe (Invited)

Global linkages of decadal variability over the North Pacific Ocean

Elizabeth A. Logerwell and Anne B. Hollowed (Invited)

The impact of environmental variability on the effectiveness of fisheries management strategies

Arthur J. Miller (Invited)

Regional impacts of large-scale climate variations on the Pacific Ocean ecosystem

Vladimir I. Radchenko

Coincidence of pink salmon catch trends among the odd-years and even-years populations: Regional and basin scale views

Eleuterio Yáñez, Claudio Silva and María Angela Barbieri

Low frequency environmental fluctuations and main Chilean pelagic fisheries

Franz J. Mueter and Bernard A. Megrey

Spatial scales and magnitudes of covariation among fish populations in the Northeast Pacific

Paul D. Spencer and Tom W. Wilderbuer

Relationships between environmental variability and eastern Bering Sea flatfish population distributions

Troy W. Buckley and Stanislaw Kotwicki

Consideration of spatial scale when assessing the influence of environmental variability on walleye pollock in the eastern Bering Sea

Peter W. Lawson

Climate impacts on OPI coho salmon, *Oncorhynchus kisutch*, production: Insights from a species sensitive to habitat change at daily to centennial time scales

S. Lyn McNutt, Two Crow (AKA, Jim Schumacher) and Phil Mundy

Integrated adaptive management applied to the Gulf Ecosystem Monitoring and Research (GEM) Program

Nathan J. Mantua (Invited)

To upscale or downscale? Thoughts on bridging disparate scales of space and time in linking the planetary to the plankton

Sinjae Yoo, Hyun-Cheol Kim and Stewart M. McKinnell (Invited)

Variability of Chl-a in the North Pacific marine ecosystems

Sei-ichi Saitoh and Takahiro Iida (Invited)

Temporal and spatial variability of phytoplankton biomass and productivity in the Bering Sea in relation to climate variability

Cara Wilson, Steven J. Bograd and Franklin B. Schwing (Invited)

Temporal variability of sea surface chlorophyll and biophysical coupling in the Pacific

Yi Chao and Fei Chai (Invited)

The impact of Pacific climate forcing on marine ecosystem

Ichiro Yasuda and Hiroaki Tatebe

Tide-induced North Pacific Intermediate Water circulation and impact on climate

Vladimir I. Ponomarev, Aleksandr S. Salomatov, Dmitry D. Kaplunenko and Natalya I. Rudykh

Relationship of different scales of climate variability in the Asian Pacific

Richard A. Feely, C. L. Sabine, R. Wanninkhof, A. Murata, R. Key, C. Winn, M. F. Lamb and D. Greeley (Invited)

CLIVAR/CO₂ Repeat Hydrography Program in the North Pacific Ocean

Raghu Murtugudde (Invited)

Tropical and extratropical modes of ecosystem variability

Poster

C. Franco-Gordo, E. Godinez-Dominguez and J. Freire

Interannual variability of the diversity and ichthyoplankton community in the central Pacific off Mexico

MEQ Workshop (W5) and HAB Meeting *Developing a North Pacific HAB data resource - II*

Co-sponsored by the Intergovernmental Oceanographic Commission (IOC)

Co-Convenors: Henrik Enevoldsen (Denmark/IOC), Hak-Gyoon Kim (Korea/PICES) and Vera Trainer (U.S.A./PICES)

Background

Harmful Algal Blooms (HABs) comprise rapid growth of both toxic and non-toxic species, and affect the marine ecology and economy of coastal nations. Monitoring and research activities aimed towards achieving effective HAB predictive and mitigation strategies are underway in each PICES member nation, in many cases dealing with similar organisms or problems. These efforts will benefit from building a common data resource among PICES nations that allow inter-comparison of HAB species composition and the magnitude of environmental and economic impacts. During the PICES XII “Data Harmonization” workshop, national representatives accepted an offer from IOC and ICES to utilize their successful harmful algal database (HAE-DAT) format on a trial basis. The goal of this data workshop was to provide an interim “report card” on the use of this database. The central tasks were:

- ascertain how well the database process worked;
- identify any difficulties in data delivery from member nations;
- assess the effectiveness of the interactive web-based window to the developing resource; and
- determine if further modifications are needed to encompass unique aspects of Pacific Rim marine resources..

Summary of presentations

Nicolaus Adams (U.S.A.) reported that differentiating separate events within sites is difficult given the large segments. Additional information on the form including magnitude of event, duration of event, the number of sites tested, maximum level of toxin, number of tests completed and number of tests above regulatory limit would be helpful. The online form was

easy to use and self-explanatory. Problems arose with reconciling HAE-DAT reports, ascertaining who the data is presented for, what specificity of data was needed, how events are separated, and what data is useful. A suggestion was made to add a more generalized row to input information on what type of “event” is being described.

Ming-Yuan Zhu (China) reported that HABs in China have apparently been increasing rapidly since the 1980s. Routine weekly monitoring started in the 1990s, and 11 red-tide monitoring areas are recognized and used for HAE-DAT data reporting. Most of the historical data is limited to information on location, time, species, economic loss and area affected. Data are hard to access due to various (regional, national and provincial) monitoring centers having responsibility for data, and possible sensitivity issues arising from data sharing. There is difficulty assessing what a “harmful event” is, *e.g.*, should all events be recorded and what levels of toxin are needed in order to record an event as harmful.

Hak-Gyoon Kim (Korea) reported that focus in recent years in his country has been on *Cochlodinium* blooms. Difficulties associated with the HAE-DAT form involve the limited (general) information to be entered. Information on magnitude, density and persistence of events is important. Difficulties arise from inconsistent data among countries and the data base process. Separation of red-tide and shellfish events as well as information on successional changes would be helpful.

Ichiro Imai (Japan) focused on aquaculture in Japan (finfish, shellfish, seaweed) that is impacted by HABs. Types of phytoplankton that cause problems include *raphidophytes*, *Chattonella*, *Heterosigma*, *Dinophysis*, *Karenia*,

Cochlodinium, *Heterocapsa* (kills bivalves) as well as the diatoms *Coscinodiscus*, *Eucampia*, *Skeletonema* (damaging to *Nori* culture, especially in winter - bleaching is bad for product and prices). Problems of HAB toxins are PSP and DSP. Currently, Japan has no ASP problem. Each of Japan's 47 prefectures monitors for red-tide, toxic bloom and shellfish poisoning, therefore there is a large amount of data. For the HAE-DAT trial, primarily *Cochlodinium* blooms were entered into the database. There are a large number of incidents. Japan decided to use 7 zones or "area codes" for HAE-DAT. Data entry is labor intensive. For this year's trial, Japan specifically selected those HAB incidents that caused fishery damage.

Tatiana Orlova (Russia) reported on the limited information entered into HAE-DAT forms. Information submitted included general information, dates and species causing events. Very limited toxicity data is available due to a lack of monitoring efforts. There was difficulty with recommended area confinements, and limited data for the recommended one year of the trial. Three years of data were considered for HAE-DAT inclusion, and the Russian Federation administration territories were used as areas.

Robin Brown (Canada), on behalf of Angelica Peña and Melanie Quenneville, reported that western Canadian HAB research is focused on harmful species affecting aquaculture operations. A large coastline has made comprehensive monitoring difficult, and data consists of marine shellfish toxicity data only. There was difficulty in deciding what constitutes an event. Those measurements where toxin was recorded above the regulatory limits were used. HAE-DAT forms are limited in the ability to comment on annual trends and previous occurrences. Area guidelines of fishery regulation areas were consolidated and used for reporting. No information on environmental parameters or microalgal abundance/presence is available. There are questions involving duration of events, variable data and definition of events, and as to whether the limited data entered for most events would be useful

scientifically. Data are difficult to compare between countries.

Robin Brown also spoke about possible areas where TCODE could integrate with HAB data activities. Some TCODE areas of priority include: data exchange, subject area prioritization, development of standards, identification of resources and collaborations.

Jeanne Allen spoke about Gulf of Mexico data integration. To date, the National Coastal Data Development Center (NCDDC, U.S.A.) has focused on *K. brevis*, through the incorporation of data from five Gulf of Mexico states plus Mexico, including data from government and private labs. Data accessibility was the key component to successful integration. Her presentation stressed the importance of open sharing of data as a key to success in international collaboration.

Conclusion and recommendations

All countries unanimously decided to adopt the HAE-DAT database as the official PICES HAB database. The database will be called the HAE-DAT IOC joint ICES/PICES database. An overall description of the PICES joint database with IOC/ICES and its goals will be written by Henrik Enevoldsen, Robin Brown, Hak-Gyoon Kim and Vera Trainer and placed on the IOC website. Each country will review the description of their monitoring program on the IOC website, and make additions by contacting the IOC point person for changes. Included will be a description of monitoring programs in each country, what constitutes a "harmful event", algae species described in the IOC database as harmful in each country, harmful levels, and "area codes" (those coastline divisions and coordinates that will be used for data entry). The numbering system and area boundaries will also be detailed. Point people for each country are as follows: Angelica Peña (Canada), Ming-Yuan Zhu (China), Yasunori Watanabe (Japan), Hak-Gyoon Kim (Korea), Tatiana Orlova (Russia) and Vera Trainer (U.S.A.). Members agreed to enter data directly into IOC's web-based database for the year 2000 (minimum) and subsequent years, if possible. All data will be

submitted to IOC by July 1, 2005, in order to give Henrik Enevoldsen time to make maps and

a presentation of data reports for PICES XIV in Vladivostok, Russia.

List of papers

Oral presentations at the MEQ Workshop

Henrik Enevoldsen and Monica Lion

The joint IOC-ICES-PICES Harmful Algal Event Data-base, HAE-DAT

Nicolaus G. Adams, Diedre Crawford, William P. Cochlan and Vera L. Trainer

Use of the ICES harmful algal event meta-database to archive data from the west coast of the United States

Ming-Yuan Zhu, Rui-Xiang Li and Zong-Ling Wang

HAB data in China

Hak-Gyoon Kim, Young-Shil Kang, Chang-Kyu Lee, Gui-Young Kim, Wol-Ae Lim, Sook-Yang Kim, Young-Tae Park, Soo-Jung Chang and Hee-Dong Jeong

Use of Korean HAB data for the joint ICES/PICES HAE-DAT database

Ichiro Imai, Shigeru Itakura, Yasunori Watanabe, Akira Ishikawa and Yasuwo Fukuyo

HAB data in Japan and a trial for joining PICES database

Tatiana Yu. Orlova

Entry of HAB data from the east coast of Russia into the ICES/PICES HAE-DAT database format

Angelica Peña and Melanie Quenneville

Testing the ICES harmful algal event meta-database to archive data from the west coast of Canada

Robin Brown

TCODE integration with HAB database efforts

Jeanne S. Allen

Data integration issues within the Gulf of Mexico

Oral presentations at the HAB Meeting

Ming-Yuan Zhu, Rui-Xiang Li and Zong-Ling Wang

The occurrences of HAB in Chinese coastal waters in recent three years

Ichiro Imai, Tomotaka Shiraishi, Kiyohito Nagai, Shingo Hiroishi, Shigeru Itakura, Yasunori Watanabe, Akira Ishikawa and Yasuwo Fukuyo

Monitoring of the shellfish-killing dinoflagellate *Heterocapsa circularisquama* in Japanese coastal sea by indirect fluorescent antibody technique

Angelica Peña

Preliminary proposal of a Canadian Program on the Ecology and Oceanography of Harmful Algal Blooms

Tatiana Yu. Orlova

Harmful algal bloom data for the Russian east coast

Hak-Gyoon Kim, Young-Shil Kang, Chang-Kyu Lee, Gui-Young Kim, Wol-Ae Lim, Sook-Yang Kim, Young-Tae Park, Soo-Jung Chang, Young-Sang Suh and Hee-Dong Jeong

Recent approaches for the prediction and mitigation of *Cochlodinium polykrikoides* blooms in Korean waters

Vera L. Trainer, Barbara M. Hickey, Mark Wells and William P. Cochlan

Ecological linkages between physical and oceanographic conditions and the seasonal growth and distribution of *Pseudo-nitzschia* blooms on the U.S. west coast

Michelle C. Tomlinson, Richard P. Stumpf, Dana L. Woodruff, Nathan R. Evans and Susan Dunham

The use of remote sensing and meteorological data for monitoring HABs through ecological associations

Ying-Lin Zou, Ming-Yuan Zhu, Rui-Xiang Li and Zhen-Xing Wu

Monitoring toxic HAB in the Chinese waters during the recent three years

MBM-AP Workshop (W6)

Combining data sets on diets of marine birds and mammals: Phase II

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Background

The workshop on “Combining data sets on distributions and diets of marine birds and mammals” at PICES XII led to enhanced knowledge of the relations of marine birds and mammals and the environment. Continuation of this workshop would further our understanding of the coupled climate-ecosystem fluctuations in the North Pacific Ocean. The PICES Advisory Panel on *Marine birds and mammals* identified some species with extensive spatial and temporal datasets on food habits and prey characteristics, which were not reviewed at PICES XII and could be examined.

Summary of presentations

Five oral presentations were made, including two talks on marine birds and three talks on marine mammals. The species discussed included Cassin’s Auklet (a secondary predator) and northern fur seal (a tertiary predator). In addition, studies of the toothed whale diet and overall cetacean communities were presented. A long-term study of seabird community response to climate variability in the northern Okhotsk Sea was also presented. A total of sixteen people were in attendance. Presentations revealed the following:

- Ohizumi and Kato demonstrated geographic and temporal variation in the diet of toothed whales in the northwestern Pacific; the importance of myctophids (lantern fish) was of particular interest for animals of the open ocean.
- Kitaysky, Zelenskaya and Glubova revealed contracting responses of planktivorous and piscivorous seabirds in the Okhotsk Sea, and how these responses were related to indices of climate and prey availability.
- Miyashita and Kato discussed the distribution and abundance of the entire cetacean community in the western North Pacific based on 20 years of systematic sighting surveys. They presented data on sperm whale population indices showing

increases in the 1980s, followed by stability in the 1990s and early 2000s.

- Ream and Zepplin reviewed and analyzed information on northern fur seal diets from the late 1950’ to the present, using data from Japan, Russia and the United States. Using an immense dataset, they demonstrated geographic variation in diet, and considered how sampling methodologies may have affected results.
- Wolf, Abraham, Hipfner and Sydeman reviewed dietary changes in Cassin’s Auklets at 4 sites in the California Current, and demonstrated prey switching at decadal and interannual time scales and with latitude. Through presentations above and associated discussions, the following points can be summarized:
 - Diet composition varies between the west and east regions of the North Pacific. Myctophids are an important prey for many species in the open ocean, whereas a series of coastal prey are important in marginal seas. Euphausiids and copepods are important for planktivorous seabirds, but diet compositions have changed through time.
 - Diet composition has switched dramatically at the decadal level, probably related to regime shifts, El Niños, and other climatic factors.
 - Marine birds and mammals including, at least, Cassin’s Auklet and northern fur seal, and species discussed last year, may be useful as ecosystem indicators of climate fluctuations, though there are some limitations with this approach. For example, understanding the dynamics of prey switching and geographic variability in diet composition is essential to interpreting variation in spatio-temporal variation in diet composition. MBM-AP, while highlighting this issue, recommends continued efforts to develop dietary and demographic indices of short-term and low frequency climate-ecosystem fluctuations.

List of papers

Oral presentations:

Hiroshi Ohizumi and Hidehiro Kato

Food of toothed whales in the northern North Pacific: Geographic and temporal variation

Rolf R. Ream and Tonya K. Zeppelin

Historical and contemporary diet of northern fur seals in the North Pacific

Alexander Kitaysky, Larisa Zelenskaya and Elena Golubova

Reproductive responses of planktivorous and piscivorous birds to climate variability in the northern Sea of Okhotsk

Shaye G. Wolf, Christine L. Abraham, L. Mark Hipfner and William J. Sydeman

Spatio-temporal variation in the zooplankton prey of Cassin's auklets in the California Current system

Tomio Miyashita and Hidehiro Kato

Distribution of cetaceans in the western North Pacific inferred from systematic sighting survey